LITERACY AND NUMERACY DIAGNOSTIC TOOLS
AN EVALUATION

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

Background

Within the context of a national drive to improve literacy and numeracy learning, the Department of Education, Employment and Workplace Relations (DEEWR) is looking at the possibility of developing a set of literacy and numeracy diagnostic tools for use in Australian schools. National commitments and initiatives, some of which were not yet announced when this project was conceptualised and the tender let, provide additional contexts for the proposed work. *See Introduction, Background, pages 8-9.*

This scoping study—a relatively small scale piece of work designed as a first step from which DEEWR might move forward—is not a direct study of 'what works to improve literacy and numeracy'. Its focus is on the identification and evaluation of the print and on-line literacy and numeracy diagnostic tools used currently in Australian schools. Particular attention is given to tools developed for the early years of schooling; those developed specifically for the transition years from primary school to secondary school and for Year 9; and those that address the needs of students who are educationally disadvantaged. The study brief specifies a range of short term, medium term and long term objectives. Medium-term objectives include improving the collective national understanding of what literacy and numeracy strategies are likely to be effective; and providing research evidence that will assist DEEWR to create the infrastructure to drive national improvement in literacy and numeracy. A long-term objective is to add to the larger body of research and development that has the goal of lifting the literacy and numeracy performance of all Australian school students.

See Introduction, Objectives, page 10.

Framing the Study

In framing the scoping study, recognition is given to the Australian National Curriculum definitions of numeracy and literacy although in the case of literacy the study focuses on reading and writing only. A distinction is made between the term 'tool' which refers to the broad set of materials described in the project specifications that include, for example, resources for teachers, and the term 'instrument' which refers to the vehicle through which evidence of a student's knowledge, skills and understandings is collected. A *diagnostic instrument* is used to *collect evidence* of students' weaknesses and strengths. It must have the power to expose, identify and/or highlight specific weaknesses and strengths in skills—at either the group level or the level of the individual student—so that interventions can be designed to improve learning.

See Defining Literacy, Numeracy and Diagnostic Tools, pages 12-15.

Seven criteria for recognising and evaluating the quality of a 'diagnostic tool' are stipulated in the project specifications; three address the diagnostic instrument; four the engagement, ease of use and support strategies provided for intervention; one communicating with parents. Four levels of diagnostic power to evaluate the diagnostic capacity of the tools and instruments are defined by ACER.

See Defining Quality Tools, pages 16-18.

Containing the Study

There is a wide range of tools within the education sector that contribute to our understanding of students' learning, including the range of tools used by specialists outside of the field of education but in support of education and sometimes used in school settings. This study addresses only those tools designed for use directly by education systems, schools and teachers—and only those tools that are designed to gather information about students' literacy or numeracy learning.

Because the study was intended as an initial small scale scoping study, the sourcing of possible tools to be included relied primarily on state, territory and national authorities and agencies providing advice via survey completion. In addition, a small number of national and international experts were approached. On the basis of a three-step process, twenty-nine literacy and thirty numeracy tools were selected, making it likely that all of the tools that are used *widely* in Australian schools have been evaluated.

The study recognises, however, that given that individual schools and teachers were not contacted directly, it is possible that *all* diagnostic tools in use have not been captured by the survey net. Other sources in a broader study could include material cited on Education Department websites, and in submissions to the National Inquiries into the Teaching of Literacy and Numeracy. *See Sourcing and Selecting Diagnostic Tools, pages 19-22.*

Central Finding and Recommendations

The central finding of the study is that the 'diagnostic tools' in use in Australian schools vary widely in their conceptualisation and intent, and in the support they provide for teachers. Some tools are developmental frameworks comprising described levels of achievement against which teachers make on-balance judgements on the basis of observations or evidence from instruments of their choice. Some tools are instruments only—vehicles through which evidence of learning is collected and assessed. Some of these instruments focus on a number of skills, some on one skill. Some tools are measurement instruments designed to assist teachers, schools and systems to monitor student learning on a single empirically based scale across the years of school. Some tools are designed as comprehensive packages that include a range of support materials for teachers. Some are designed for teacher use only, others for communication with parents and students.

These differences in conceptualisation and intent provide a useful frame of reference for comparing tools at a descriptive level, but challenge the possibility of meaningful tool-by-tool evaluation.

To accommodate this central finding the emphasis of the study shifts from a focus on the short-term objectives to a focus on the medium term objectives, in particular to providing research evidence that will assist DEEWR to create the infrastructure to drive national improvement in literacy and numeracy. To this end, the evaluations are synthesised under a conceptual framework of diagnostic power.

Tools at the lowest level of diagnostic power comprise frameworks—described levels of achievement against which student learning can be judged, reported and monitored. Because the instruments or vehicles through which teachers *collect evidence* of students' weaknesses and strengths and from which they draw an inference back to a level on the framework are not specified, frameworks have been assigned Level 1 diagnostic power.

Instruments of Level 2 diagnostic power are designed primarily for system-wide assessment and for the monitoring of student learning across the years of schooling and over time. They provide limited information about the strengths of low achieving students (who succeed on very few items) and the weaknesses of high achieving students (who succeed on all or almost all items). They do provide indications of potential problem areas; for example, if an entire class does poorly on questions of a particular kind; or if an individual student fails to answer questions that, based on their ability estimate, they would have been expected to complete correctly.

Instruments of Level 3 diagnostic power provide information about individuals' strengths and weaknesses on narrowly defined domains or sub-domains. Instruments of Level 4 diagnostic power provide very detailed, extensive information on students' knowledge and understandings of narrowly defined skills or clusters of skills.

In their practice, accomplished teachers use diagnostic information from tools of Level 1 to Level 4 diagnostic power as they 'drill down' to obtain detailed information about a student's knowledge, skills and understandings. Underpinning the idea of increasing diagnostic power is the reality of increasing amounts of evidence of an increasingly *focused* kind.

See Kinds of Diagnostic Information, Pages 17-18.

Using this framework of diagnostic power together with the evaluation criteria addressing student engagement, ease of use, strategies for intervention, and communicating with parents, it is possible to identify the gaps in sources of information available for teachers.

Recommendations based on this central finding take the following into account:

- Teachers need access to a variety of tools and instruments of different diagnostic power in order to adequately assess the literacy and numeracy knowledge, skills and understanding of their students. In their practice, accomplished teachers use diagnostic information from tools of different levels of diagnostic power as they 'drill down' to obtain detailed information.

- There is a wide range of tools available now for teacher use but they do not (and nor could they be expected to) work together as a coherent suite of resources. It is difficult for schools and teachers to access the tools as a set and to make an informed selection from that set.

- Schools and teachers need support to select instruments of appropriate diagnostic power for different purposes; and they need support in the form of additional resources so that they are able to make effective use of diagnostic information at the school, classroom and individual student level.

- Taken together (that is, across states and territories), the Early Years tools provide a more coherent and comprehensive set than those for the Transition Years and Year 9.

- The national collaboration to develop a single curriculum framework with accompanying achievement standards, and the refinement of the *National Assessment Program for Literacy and Numeracy* (*NAPLAN*) provides a context for a national approach to the provision of diagnostic resources for teachers.

- The task of developing, refining and selecting diagnostic instruments is an ongoing one.

Recommendation 1

That a national data base of literacy and numeracy diagnostic tools be established and maintained.

The data base would be organised by literacy and numeracy (the broad content focus) and power of diagnosis (the sub-skill content focus). Tools would be grouped by stage of schooling.

The initial population of the data base would include materials sourced for this study (national, state and territory, and commercial); tools and instruments referred to in submissions to the national literacy and numeracy reviews; and the broad range of diagnostic tools and instruments recommended for use on state/territory department websites.

Recommendation 2

That two suites of diagnostic tools for use by classroom teachers nationally be developed: one for literacy and one for numeracy.

These suites are not intended to replace all the tools currently in use but to provide a coherent backbone of tools that is research based and that addresses the particular needs of Australian students.

For the Early Years, each suite would contain tools of Level 1 diagnostic power together with instruments of level 4 diagnostic power.

For the Transition Years and Year 9, each suite would contain instruments of levels 3 and 4 diagnostic power.

Instruments would be based on the essential capabilities that underpin literacy and numeracy skills as derived from research literature; would address the knowledge and skills detailed in the new National Curriculum; and would be consistent with, but not limited to, the knowledge, skills and understandings assessed in the national monitoring test, *NAPLAN*.

The instruments would be available on-line and in paper form. They would be designed to engage students and to utilise the on-line medium to enhance delivery and reporting.

Each suite would contain teacher support materials drawn from current state and territory resources and supplemented as necessary. See Recommendations 3 and 4 also.

Findings and Recommendations specific to stages of schooling

Except in the Early Years (and school entry in particular) teachers are using a wider range of diagnostic tools to assess and monitor students' numeracy learning than to assess and monitor students' literacy learning. More numeracy than literacy tools are in use; and as a set the numeracy tools are able to provide more detailed diagnostic information than the set of literacy tools. Several explanations for this finding are suggested.

See Final Reflections, page 55.

Early Years

Taken together, the frameworks and support materials in use across the country by teachers working in the Early Years provide a more comprehensive set of resources than is currently available to teachers in any single state/territory. However, there are few instruments, particularly in the case of literacy, that drill down to provide detailed information on the sub-skills that are addressed in the frameworks.

The 2005 National Inquiry into the Teaching of Literacy recommended the measurement of individual progress in literacy by regularly monitoring the development of each child and reporting progress twice each year for the first three years of schooling. Currently, there are no measurement instruments available to support this recommendation.

In the case of literacy, we now have clear research evidence on the nature of early reading skills and therefore a research-based focus for reading instruments. There is less comprehensive evidence for underpinning writing skills (and oral language skills, which although beyond the scope of this project are particularly important in the Early Years). Looking beyond school entry, few tools available for use in the Early Years address a wide range of writing skills.

Recommendations based on these Early Years findings take the following into account:

- For school entry assessment teachers will need to undertake individual interviews and, in the case of numeracy, use concrete materials to assess most students' knowledge and skills.

- In the case of numeracy, a challenge to developing instruments for use with students in Years 2 and 3 (and for some students in the Transition Years and Year 9) is to provide opportunities for them to demonstrate what they know, understand and can do without mediating the assessments through reading.

- In the case of numeracy, it is also a challenge to provide opportunities (in paper and pen, and on-line assessments) for students to demonstrate the strategies they are using.

- Before a fully comprehensive range of literacy diagnostic tools can be provided some additional research will need to be undertaken.

Recommendation 3

That states and territories combine their expertise and draw on the strengths of current resources (both frameworks and instruments) to develop the basis for the Early Years component of the two suites of diagnostic tools (literacy and numeracy) for use by classroom teachers nationally.

The tools would include components for optional use; for example, additional resources for teachers working with Indigenous students.

Recommendation 4

That a set of *measurement* instruments be developed to assist teachers (and schools) to better monitor literacy learning from Year 1 to Year 3. These instruments would be of level 4 diagnostic power—focusing on the sub-skills of early reading. The instruments would include sets of parallel forms to allow teachers to assess students twice yearly.

Transition Years and Year 9

Bearing in mind the limitations of the study methodology, there are very few diagnostic tools and instruments that have been developed specifically for the Transition Years and Year 9 in use in Australian schools.

Only three literacy tools developed specifically for the Transition Years were cited (one of which is Australian), and one was cited for Year 9—a Canadian instrument. This raises a question about the necessity for specific tools and/or instruments for students in these Year levels. Are instruments that focus on understandings particular to these Year levels required; or are instruments that are particularly engaging required? For example, in the case of literacy, care needs to be taken to ensure that reading materials with low language demand retain sophisticated conceptual content. Perhaps in the case of numeracy, it is particularly important to distinguish between instruments that assess skills and instruments that assess underpinning concepts or 'big ideas' that have not been grasped.

While four of the five skills that underpin early reading are well defined and articulated consistently in the research literature, there is less explicit agreement about the skills that are fundamental to 'reading comprehension'. Sometimes these aspects are made explicit, often not. Sometimes they can be inferred from achievement reports where 'descriptors' of the skills addressed by each item are provided.

There is a task to clarify the reading comprehension skills that students are expected to develop as they move through the Transition Years of school (and beyond). One perspective could come from a comparison of the set of skills made explicit in the new national curriculum; the *NAPLAN*; the *Program for International Student Assessment* (*PISA*); and the *Progress in International Reading Literacy Study* (*PIRLS*). Another more curriculum-based perspective could come from a national inquiry into the teaching of reading comprehension.

Given that most of the instruments used in the Transition Years and Year 9 are also used across the years of schooling, the most important consideration in the use of these tools is the degree to which the set of tools provides teachers with increasingly diagnostic information of varying degrees of power. In addition, the degree to which support materials increase the diagnostic capacity of a particular instrument, and the degree to which professional development activities assist teachers to use diagnostic tools effectively are critical.

The need for instruments that provide detailed and precise information on the strengths and weaknesses of *each* student cannot be underestimated. This is the case whether a student is considered to be advanced in their learning, or in need of support to reach grade expectations. There is growing research evidence to support the tailoring of intervention to the needs of individual students and to 'establishing classroom routines and practices that represent personalized, ongoing, data-driven focused instruction' (Fullen, Hill and Crevola, 2006, p.4; Bransford et al., 2000).

Future Explorations

To strengthen the research base on which future work in the area of literacy might be undertaken and to provide teachers with access to high quality numeracy and literacy diagnostic tools, three areas for future exploration are suggested.

One, that a national inquiry into the teaching of 'reading comprehension', which extends the scope of the 2005 National Inquiry into the Teaching of Literacy (Reading), be considered. The findings of this inquiry would inform the future development of diagnostic reading tools; support teachers' understanding of reading development beyond the middle primary years; and, although outside the scope of the current study, provide a research based framework for the national monitoring of reading.

Two, that a national inquiry into the teaching of writing to complement the 2005 National Inquiry into the Teaching of Literacy (Reading) be considered. The findings of this inquiry would inform the development of diagnostic writing tools; support teachers' understanding of writing development; and, although outside the scope of the current study, provide a research based framework for the national monitoring of writing.

Three, that the establishment of an Australian Institute for the evaluation of literacy and numeracy diagnostic tools be considered. The Institute would be responsible for the maintenance of the national data base of literacy and numeracy diagnostic tools; including reviewing materials for possible inclusion, commissioning new materials, developing resources to support tools and instruments already in use; providing professional development activities for teachers. The US Buros Institute provides a reference for the development of such an Institute—although the Australian Institute should not limit its reviews to measurement instruments.

1. INTRODUCTION

Background

On 5 December 2008, State, Territory and Commonwealth Ministers of Education meeting as the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) released the Melbourne Declaration on Educational Goals for Young Australians. This Declaration, which supersedes the 1999 Adelaide Declaration, sets the direction for Australian schooling for the next 10 years.[1]

The Declaration makes explicit that improving educational outcomes for all young Australians is central to the nation's social and economic prosperity and will position young people to live fulfilling, productive and responsible lives. The Declaration also makes explicit that literacy and numeracy, and knowledge of key disciplines, remains the cornerstone of schooling for young Australians.

In support of these goals, the 2008-09 Federal Budget announced funding of $577.4 million over four years to deliver a National Action Plan for Literacy and Numeracy to improve literacy and numeracy outcomes—with a focus on teaching, leadership and the effective use of student performance information to deliver sustained improvement in literacy and numeracy outcomes for all students, especially those who are falling behind.

The centrepiece of this budget initiative is the National Partnership Agreement with funding of $540 million for Literacy and Numeracy initiatives and an additional $30 million for Literacy and Numeracy pilots in low socio-economic status communities.[2] The Agreement supports specific projects that will deliver nationally significant reforms.

The Literacy and Numeracy Partnership refers to:

- effective and evidence-based teaching of literacy and numeracy;
- strong school leadership and whole school engagement with literacy and numeracy;
- improving literacy and numeracy for primary school students, especially Indigenous students;
- monitoring student and school literacy and numeracy performance to identify where support is needed; and
- developing a national understanding of what is the most effective way to teach literacy and numeracy.

Specific objectives include the identification and implementation of evidence-based interventions which achieve accelerated and sustained improvements in literacy and numeracy outcomes for students, particularly those falling behind.

Several other recent national initiatives and commitments also provide further context for this study. The 2005 *National Inquiry into the Teaching of Reading* commissioned by the Department of Education, Science and Training (DEST) recommended that the teaching of literacy throughout schooling be informed by comprehensive, diagnostic and developmentally appropriate assessments of every child, mapped on common scales. Further, it recommended

[1] http://www.mceetya.edu.au/verve/_resources/National_Declaration_on_the_Educational_Goals_for_Youg_Australians.pdf (retrieved 19 May 2009)

[2] http://www.coag.gov.au/intergov_agreements/federal_financial_relations/docs/national_partnership/national_partnership_on_literacy_and_numeracy.pdf (retrieved 19 May 2009)

that nationally consistent assessments on entry to school be undertaken for every child, including regular monitoring of decoding skills and word reading accuracy using objective testing of specific skills, and that these link to future assessments; that education authorities and schools be responsible for the measurement of individual progress in literacy by regularly monitoring the development of each child and reporting progress twice each year for the first three years of school; and that the Years 3, 5, 7 and 9 national literacy testing program be refocused to make available diagnostic information on individual student performance, to assist teachers to plan the most effective teaching strategies.[3]

A school entry literacy and numeracy assessment system was noted as a priority area of the National Reform Agenda endorsed by the Council of Australian Governments (COAG) in 2006. The *National Numeracy Review* commissioned by the Human Capital Working Group of COAG and released in May 2008 recommended school entry assessments as well as the use of diagnostic tools at other year levels.

The Australian Early Development Index (AEDI) announced by the Deputy Prime Minister in the May 2008 budget will measure progress in the five developmental domains of physical health and well-being, social competence, emotional maturity, language and cognitive skills, and communication skills and general knowledge.

The Australian Curriculum (April 2009) cites as one of its educational goals for young Australians: successful learners have the essential skills in literacy and numeracy and are creative and productive users of technology, especially ICT, as a foundation for success in all learning areas. 'The curriculum will include a strong focus on literacy and numeracy skills'.[4]

Within the context of these initiatives and commitments, a number of which were not yet clear when the project was conceptualised and the tender let (November 2008), the Department of Education, Employment and Workplace Relations (DEEWR) is looking at the possibility of developing a set of literacy and numeracy diagnostic tools for use in Australian schools with the intention of supporting the national drive to improve literacy and numeracy learning.

[3] Australian Government, Department of Education, Science and Training (2005). *Teaching Reading, Report and Recommendations, National Inquiry into the Teaching of Literacy*. Recommendation 9, p. 47.
[4] National Curriculum Board. (April 2009). *The Shape of the Australian Curriculum*, Boxes 2 and 3, pages 7 and 9.

Objectives

The short term objective of this study is to identify and evaluate the print and on-line literacy and numeracy diagnostic tools used currently in Australian schools—with a focus on the early years of schooling; tools developed specifically for the transition years from primary school to secondary school; Year 9; and the needs of students who are educationally disadvantaged. For the purposes of the study, 'literacy' is limited to reading and writing in English.

In particular, the short term objectives include:

- describing the diagnostic tools and how they are being used;
- describing the resources in place to support teachers in the use of these tools;
- evaluating the quality of the tools;
- identifying, describing and evaluating diagnostic tools used in a small number of other countries that could be considered for use in Australian schools;
- making recommendations on whether to support the use of existing literacy and numeracy diagnostic tools or commission the development of a new set of literacy and numeracy diagnostic tools suitable for national use; and
- commenting on how the diagnostic tools will complement the AEDI.

The medium term objectives of the study are to:

- improve the collective national understanding of what literacy and numeracy strategies 'work' by identifying the diagnostic tools that are most effective in identifying gaps in students' literacy and numeracy skills, and that provide the most suitable strategies for addressing these gaps; and
- provide research evidence that will assist DEEWR to create the infrastructure to drive national improvement in literacy and numeracy; in particular, to develop a set of literacy and numeracy diagnostic tools for use in Australian schools.

The long term objective of the study is to add to the larger body of research and development that has the goal of lifting literacy and numeracy performance of all Australian school students.

It is important to note that the study was conceptualised primarily as a scoping study—a relatively small scale piece of work designed as a first step from which DEEWR might move forward.

This study is not a direct study into 'what works to improve literacy and numeracy'. Such a study would require a long term exploration of the impact of each tool and program under consideration. While the report addresses the short and medium term objectives of the project, its contribution to the long-term objective of lifting the literacy and numeracy performance of all Australian school students is indirect.

Structure of the report

The report follows a chapter structure that parallels the conceptual and operational narrative of the study.

Chapters 2 and 3 focus on the *conceptual parameters* of the work. Here key terms are explored and defined: 'literacy', 'numeracy', 'diagnostic tools' and 'quality tools'. These chapters are critical to understanding the framework within which the diagnostic tools are evaluated.

Chapter 4 focuses on the *procedural aspects* of the study including sourcing and selecting the diagnostic tools to be evaluated. This chapter is critical to understanding the scope (breadth and constraints) of the study.

Chapters 5 and 6 address the core of the study: the evaluation of the selected literacy and numeracy diagnostic tools.

Within each of chapters 5 and 6, the tools are categorised and discussed in sub-sections that focus in order on: the Early Years tools (school entry to Year 3 inclusive); the Transition Years tools (Year 4 to Year 8 inclusive) and the Year 9 tools. The findings detailed in each chapter provide the research evidence from which recommendations are drawn.

Chapter 7 provides reflections on the total set of literacy and numeracy diagnostic tools. It includes an overall picture of the current suite of tools used in Australian schools and highlights the gaps in available resources to assist schools, teachers, students and parents to improve students' literacy and numeracy learning.

2. DEFINING LITERACY NUMERACY AND DIAGNOSTIC TOOLS

There is a wide range of tools within the education sector that contribute to our understanding of students' learning, including the range of the tools used by specialists outside of the field of education but in support of education and sometimes used in school settings (for example, tools used by speech pathologists). This study addresses only those tools designed for use directly by education systems, schools and teachers—and only those tools that are designed to gather information about students' 'literacy' or 'numeracy' learning.

Literacy

There is no single internationally accepted definition of 'literacy'. However, it is clear that over time the term has begun to address more complex understandings than when 'being literate' was defined by the ability to read and write. It also is clear that definitions of literacy, as expressed in Australian Federal and State and Territory policy documents, are of increasing breadth and reflect a growing emphasis on context.

The *Policy Directions Paper for the 1990 International Literacy Program* in Australia refers to the concept of *active* literacy:

> For an advanced society, such as Australia, our goal must be an active literacy which allows people to use language to enhance their capacity to think, create and question, which helps them to participate more effectively in society (DEET, 1991, p.35).

The term *functional* literacy recognises that literacy exists in a context:

> A person is functionally literate who can engage in all those activities in which literacy is required for effective functioning of his group and community and also for enabling him to continue to use reading, writing and calculation for his own and the community's development (DEET, 1991, p.34; UNESCO, 2006, p.30).
>
> Literacy involves the integration of speaking, listening and critical thinking with reading and writing. Effective literacy is intrinsically purposeful, flexible and dynamic and continues to develop throughout an individual's lifetime (DEET, 1991, p. 9).

The following definition adopted in 1991 by the Australian Language and Literacy Policy refers to the concept of *effective* literacy:

> Literacy is the ability to read and use written information appropriately in a range of contexts. It is used to develop knowledge and understanding, to achieve personal growth and to function effectively in our society. Literacy also includes the recognition of numbers and basic mathematical signs and symbols within text.

More recently 'literacy' is defined in the 1998 Australian Government's literacy policy as the ability to read and use written information, to write appropriately, in a wide range of contexts, for many different purposes, and to communicate with a variety of audiences. Literacy is integrally related to learning in all areas of the curriculum, and enables all individuals to develop knowledge and understanding. Reading and writing, when integrated with speaking, listening, viewing and critical thinking, constitute valued aspects of literacy in modern life (DEETYA, 1998).

The New South Wales Department of Education and Training curriculum support materials have adopted the 'four resources framework' (Freebody & Luke, 1990) to describe and structure literacy planning and professional development. This framework is based on four sets of practices in which students develop capabilities within four roles: 'code breaker',

'meaning maker', 'text user', and 'text analyst'. These practices need to be developed within a range of genres and social situations that require reading, writing, speaking, listening and viewing engagement.

Most recently, the National Curriculum Board *Shape of the Australian Curriculum—English* refers to literacy as follows:

> Literacy conventionally refers to reading, writing, speaking, viewing, and listening effectively in a range of contexts. In the 21st century, the definition of literacy has expanded to refer to a flexible, sustainable mastery of a set of capabilities in the use and production of traditional texts and new communications technologies using spoken language, print and multimedia. Students need to be able to adjust and modify their use of language to better meet contextual demands in varying situations (National Curriculum Board, 2009, p.6).

This study recognises the National Curriculum Board's definition of literacy but does not attempt to explore the range of ways in which tools address, or might be developed to address, this broad compass of skills. Rather, it focuses on a far more limited subset: tools that assess reading and writing.

Numeracy

As with literacy, there is no single internationally accepted definition of 'numeracy'. Indeed the term numeracy (originally a British term) is rarely used outside Britain, Australia and New Zealand. In other parts of the world the terms 'quantitative literacy' or 'mathematical literacy' are used.

The 2008 *National Numeracy Review Report* noted that:

> numeracy is at times thought of as a subset of school mathematics, the 'basic mathematics' needed for every day or perhaps the basic building blocks of school mathematics, the foundations, and at other times as somewhat more than mathematics, involving a grasp of the interplay between mathematics and the social contexts within which it is used. Clearly there are ambiguities, with 'mathematics' and 'numeracy' being used almost interchangeably at times and at other times regarded as quite distinct (Commonwealth of Australia, 2008, p.3).

Willis defines numeracy as the capacity 'to use mathematics—at work, at home, and for participation in community or civic life'.

> That is, not the acquisition of even a large number of decontextualised mathematical facts and procedures, but practical mathematics which has its origins and/or importance in the physical or social world rather than in the conceptual field of mathematics itself (Willis, 1992, pp.5-6, quoted at length in the *National Numeracy Review Report*).

The Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA) in its 1997 *National Report on Schooling in Australia* defines numeracy as:

> 'the effective use of mathematics to meet the general demands of life at school and at home, in paid work, and for participation in community and civic life' (MCEETYA 1997, p.130).

The Australian Association of Mathematics Teachers (AAMT) describes numeracy as involving:

> … the disposition to use, in context, a combination of: underpinning mathematical concepts and skills from across the discipline (numerical, spatial, graphical, statistical

> and algebraic); mathematical thinking and strategies; general thinking skills; [and] grounded appreciation of context (AAMT, 1997, p.15);

and its relationship with school mathematics as follows:

> Numeracy is not a synonym for mathematics, but the two are clearly interrelated. All numeracy is underpinned by some mathematics; hence school mathematics has an important role in the development of young people's numeracy. The implemented mathematics curriculum (i.e. what happens in schools) has a responsibility for introducing and developing mathematics, which is able to underpin numeracy. However this 'underpinning of numeracy' is not all that school mathematics is about. Learning mathematics in school is also about learning in the discipline–its structure, beauty and importance in our cultures. Further, while knowledge of mathematics is necessary for numeracy, having that knowledge is not in itself sufficient to ensure that learners become numerate (1997, pp.11-12).

Three dimensions through which students develop numeracy capability are identified: learning the mathematical content—knowledge to be understood and applied or 'school' mathematics; developing a repertoire of strategic mathematical processes, skills and strategies for use in the real and practical world; and being able to select the appropriate process, skill or strategy to apply in a particular context.

The 2009 National Curriculum Board *Shape of the Australian Curriculum-Mathematics* defines numeracy as follows:

> Numeracy is the capacity, confidence and disposition to use mathematics to meet the demands of learning, school, home, work, community and civic life. This perspective on numeracy emphasises the key role of applications and utility in learning the discipline of mathematics, and illustrates the way that mathematics contributes to the study of other disciplines (p.5).

This study recognises the National Curriculum Board's definition of numeracy.[5]

Diagnostic tools

There are many different contexts for the assessment of student learning—from teachers' informal classroom observations to high-stakes entrance tests and certification examinations. Within these contexts much has been written about distinctions between assessment purposes; that is, the uses to which assessment data are put. In particular, attention has focused on the broad distinction between summative assessments (assessments *of* learning) for reporting students' levels of achievement including through state-wide and national tests such as Australia's National Assessment Program for Literacy and Numeracy (NAPLAN); and formative assessments (assessment *for* learning) where achievement data are used directly to feed into the teaching cycle (e.g. Black & Wiliam, 1998).

As the *National Numeracy Review Report* (2008) noted, many educators see a clear distinction between the two roles and argue that system-wide tests have no diagnostic role that results in the improvement of student outcomes (e.g. Shepard, 2000). Others, such as Masters (2006) see the roles as complementary, arguing that what matters is how data from a test are used and the quality of the feedback.

[5] …noting that the way in which numeracy learning is experienced by students will differ with Year level. For example, numeracy in the Early Years may focus strongly on the building blocks of mathematics.

In defining literacy and numeracy diagnostic tools, this study does not make a distinction between the contexts of assessment or their stated primary purposes. Rather, it focuses on the level of information provided by the diagnostic tool and the diagnostic *instrument*—the vehicle for collecting evidence about students' knowledge, skills and understandings. The diagnostic instrument is central to the broad set of materials described in the project specifications as diagnostic tools.

The diagnostic instrument must have the power to expose, identify and/or highlight specific weaknesses and strengths in skills—at either the group level or the level of the individual student—so that interventions can be designed to improve learning. A numeracy test that addresses students' number, measurement, space, chance and data understandings (primarily for system monitoring purposes) cannot provide the same fine-grained information about students' understanding of fractions, as a tool designed specifically for that purpose.

In defining literacy and numeracy diagnostic *tools*, this study does make a distinction between frameworks against which students' learning might be reported and monitored, and vehicles through which evidence of student learning might be collected. For example, the First Steps Reading Continuum is a framework. Running Records is an instrument through which evidence of a student's reading strengths and weaknesses can be observed and recorded. An inference could be drawn from Running Records evidence to make a judgement about the level at which a student is achieving along the First Steps Reading Continuum; but the continuum is not itself a diagnostic instrument although it may be part of a suite of diagnostic tools.

3. DEFINING QUALITY TOOLS

Seven criteria for recognising and evaluating 'quality' were stipulated in the project specifications. For the purposes of this study they were restructured[6] and reordered into three categories as follows.

In relation to their *diagnostic capacity* quality tools:

- are based on the essential capabilities that underpin literacy and numeracy skills as derived from research literature;
- provide a picture of a student's strengths and weaknesses in literacy and numeracy capabilities—in relation to the described intent of the tool and the essential capabilities that underpin literacy and numeracy skills; and
- have the capacity to identify gaps in students' literacy and numeracy skills (the validity of the instrument) and provide sufficient evidence from which inferences about gaps in students' literacy and numeracy skills might be made (the reliability of the evidence).

In relation to *engagement, ease of use and support for intervention* quality tools:

- are engaging for students—with reference to survey responses;
- are easy to use by teachers and in diverse school communities—as evidenced by the quality of the administration instructions and the degree to which the resources in place to support teachers in the use of the tools address the needs of diverse school communities;
- guide teachers in adopting particular classroom-based interventions and approaches to meet the literacy or numeracy learning needs of individual students—as evidenced by the way in which student achievement is reported and the resources in place to support teachers in the use of the tools, including suggested strategies to address an individual student's literacy and numeracy needs; and
- provide the most effective strategies to address students' needs—with reference to the support resources in place, the alignment of the suggested strategies with international research evidence and, where there is evidence from longitudinal research studies, improvement shown in literacy and numeracy learning outcomes for students whose teachers have used a particular tool and accompanying strategies.

In relation *to communicating with parents* quality tools:

- provide a basis for reporting to parents—with reference to national research studies into what parents want.[7] Appendix 1 provides further information on the refinement of this criterion.

Structuring the criteria into these three groups clarifies a critical distinction between the instrument used to collect evidence of learning, and the support provided to teachers to respond to the collected evidence and to communicate information to parents. This clarification highlights the different 'order' of the sets of criteria. The fundamental consideration in the development of diagnostic materials is the capacity of the diagnostic instrument which sits at the heart of the broader set of materials (the broadly defined tool), to identify gaps in students' literacy or numeracy skills, knowledge and understandings. While

[6] The criterion 'are engaging for students and provide a basis for reporting to parents' was divided into 2 separate criteria.

[7] Including for example, Cuttance, P., & Stokes, S. (2000). *Reporting on Student and School Achievement*. Research report prepared for the Commonwealth Department of Education, Training and Youth Affairs.

producing and refining support materials for teachers and considering ways to communicate information to parents are extremely important, their effectiveness in improving literacy and numeracy learning will ultimately depend on the quality of evidence collected.

In this report, the term 'tool' refers to the broad set of materials as described in the project specifications including, for example, strategies for teachers. The term 'instrument' refers to the vehicle through which evidence of a student's knowledge, skills and understandings is collected.

Kinds of diagnostic information

There are many different kinds of diagnostic information. In their 2001 New Zealand *Stocktake/evaluation of Existing Diagnostic Tools in Literacy and Numeracy, in English* Croft, Strafford and Mapa distinguish between a 'diagnostic tool' and 'general assessment tool from which diagnostic information may be gained'. They differentiate between instruments that are primarily diagnostic, and instruments that are designed primarily for assessing achievement, but from which information can be gained to help identify an individual's strengths, weaknesses and possible subsequent teaching strategies.

In the present study *diagnostic power*—the power to expose, identify and/or highlight specific weaknesses and strengths in skills so that interventions can be designed to improve learning—is both the reference for understanding different kinds of diagnostic information, and for evaluating a tool and an instrument's 'capacity to identify gaps in students' literacy and numeracy skills'. For example, some instruments are broadly framed tests designed primarily for monitoring student learning across the years of school at the cohort and sub-group level. Some are narrowly focused on 'digging down' to gather evidence about an *individual's* knowledge of a single tightly defined skill (e.g. phonemic awareness).

Within a conceptual framework of diagnostic power four levels are defined. The lowest level of diagnostic power, Level 1, comprises frameworks—described levels of achievement against which student learning can be judged, reported and monitored. The instruments or vehicles through which teachers *collect evidence* of students' weaknesses and strengths and from which they draw an inference back to a level on the framework are not specified. Tools of Level 1 diagnostic power are excluded from the study except where they are used as part of Early Years assessments.

Level 2 diagnostic power comprises diagnostic instruments designed primarily for system-wide assessment and for the monitoring of student learning across the years of schooling and over time. These instruments provide *measures* of achievement of broadly defined domains along empirically based measurement scales. They are professionally developed objective tests underpinned by modern measurement techniques. For system managers the interest is in cohort and subgroup achievement at particular age or grade levels, but information about individuals' achievements, class achievement, and school achievement is also sometimes provided to schools, teachers and parents. Level 2 instruments provide limited information about the strengths of low achieving students (who succeed on very few items) and the weaknesses of high achieving students (who succeed on all or almost all items). However, they do provide indications of potential problem areas that can be investigated further; for example, if an entire class does poorly on questions of a particular kind; or if an individual student fails to answer questions that, based on their ability estimate, they would have been expected to complete correctly.

Instruments of Level 3 diagnostic power provide information about individuals' strengths and weaknesses on narrowly defined domains or sub-domains. In addition, they sometimes provide multi-test forms to allow for the targeted measurement of students of very different achievement levels. Where they provide measures of achievement along empirically based measurement scales, they can be used both for measuring and monitoring learning across the years of school and for diagnostic purposes.

Instruments of Level 4 diagnostic power are designed to provide very detailed, extensive information on students' knowledge and understandings of narrowly defined skills or clusters of skills. It is uncommon to find Level 4 instruments that provide measures of achievement along empirically based measurement scales as the intention is to diagnose specific strengths and weaknesses in students' understanding, rather than to monitor learning.

In their practice, accomplished teachers use diagnostic information from tools of Level 1 to Level 4 diagnostic power as they 'drill down' to obtain detailed information about a student's knowledge, skills and understandings.

4. SOURCING AND SELECTING DIAGNOSTIC TOOLS

Sourcing tools

As the project was conceptualised as a relatively small scoping study, tool identification relied primarily on survey feedback from jurisdictions and a small number of national and international experts including:

- state, territory and national authorities and agencies (including Departments and Ministries of Education, and a sample of Catholic and Independent Schools offices and Teachers' Associations);
- a small number of Australian literacy and numeracy educators with the relevant specialties; and
- a small number of international experts from the UK, Canada, New Zealand, and Hong Kong.

The study did not seek input from individual schools or teachers.

After an initial phone conversation (except for international contacts) participants were emailed a letter of invitation, a description of the project and the survey to complete and return. Participants were provided with a definition of a 'diagnostic' tool (one that is used for identifying gaps in students' literacy and numeracy skills) but not for an 'on-line' instrument. Additional information on suggested tools was sourced via desk research and conversations with participants who had completed the Survey.

It is important to note that it is likely that individual schools and/or teachers are using diagnostic tools that have not been captured by the survey net (particularly, but not only, in the Independent and Catholic sectors). For example, a brief review of Education Department websites found thirteen additional tools cited in an 'audit of diagnostic tools' on the South Australian Department of Education and Children's Services website.[8] Submissions to the National Inquiry into the Teaching of Literacy suggest that a number of additional tools are in use; although it is difficult to determine how widely.[9]

Selecting tools and refining the evaluation process

Survey responses indicated that 102 literacy and numeracy diagnostic tools were in use in Australian schools. International experts suggested that we might explore fifteen additional instruments in use in New Zealand, Canada and Hong Kong.

The project methodology called for a three-stage selection and evaluation process:

- a brief review/evaluation/description of all tools cited in Survey responses and suggested by international experts;
- the selection of a smaller subset of tools for inclusion in the study; and
- a detailed evaluation of each tool included in the subset.

To facilitate the process, researchers developed and trial tested an 'evaluation checklist' based on the seven criteria elaborated in Chapter 3. The refined checklist, the 'diagnostic tools evaluation sheet', was used at each stage of the process. The criteria on which the checklist was based are detailed below in Table 1.

[8] www.senioryears.sa.edu.au/files/.../Audit_of_Diagnostic_Tools.doc

[9] On the other hand, if the New Zealand stocktake experience (Croft, 2001) is relevant, Australian teachers, if approached, also may have interpreted diagnostic 'tool' as a process such as observation or daily monitoring and provided little additional information.

In the first stage of the process researchers relied primarily on information provided in the Surveys, supplemented as necessary with information obtained from web searches and conversations with national experts. During the third stage of the process researchers added information gained from a direct examination of the instruments, where this was possible.

Table 1 Diagnostic tools evaluation sheet criteria and sub-criteria

Criteria	**Sub criteria**
Is fit for purpose and technically sound	Is fit for purpose
	Is technically sound
Provides a picture of a student's strengths and weaknesses	Matches the described intent of the tool (i.e. is designed to illuminate 'gaps')
	Includes information on achievement of the skills that underpin reading and writing (for Literacy) or the skills that define a numerate person (for Numeracy)
Has the capacity to identify gaps in students' literacy	Has the potential to bring forth good evidence about student achievement (this is about validity). Has the potential to bring forth sufficient evidence for making inferences about student achievement (this is about reliability)
Is easy to use by teachers and in diverse school communities	Contains clear and sensible instructions to support general administration
Guides teachers in adopting particular classroom-based interventions and approaches to meet the learning needs of individuals	Includes support for teachers in understanding what the tool is measuring (and therefore what is expected of their students)
	Includes strategies for teachers in addressing individual student needs identified by the tool
	Contains extra advice on practicalities of administration with specific groups
Provides a source of effective strategies to address students' needs	Produces accurate information on expected outcomes of suggested strategies (which are documented with the tool)
Is engaging for students and a basis for reporting to parents	Possesses many of the attributes that are known to engage students
	Possesses many of the reporting attributes valued by parents
	Suggests strategies (which are documented with the tool) that are aligned with international research evidence

For a tool to be automatically included into the study, two criteria needed to be met:

- breadth of use or 'reach'—based on frequency of mention in survey responses and limited information on sales of commercially available instruments; and
- quality of instrument—based on a high ranking overall on the seven criteria specified in the tender.

Given the small number of tools that meet either or both of the criteria for automatic inclusion in the study, an additional set of criteria were applied.

A tool was included if it was

- relevant to the student subgroups of special interest (for example, transition years students);
- recommended by our international or national experts;
- forward looking—had the potential to inform future directions in diagnostic testing of literacy or numeracy across Australia (for example, in the case of numeracy, is 'state-of-the-art, challenges traditional views, is based on a 'big picture' view, deals with problems and practices of substance in the real world and includes open-ended authentic applications or mathematics to solve meaningful problems); or is likely to have positive backwash effects on either literacy/numeracy per se or other aspects of the curriculum;
- accompanied by research—receives favourable reviews in published research or is accompanied by research evidence to support a claim that the use of the tools has led to improvements in students' literacy and/or numeracy outcomes;

- computer delivered possibly with interactive items, capacity for self-assessment or linked tuition; and
- used extensively overseas or highly regarded overseas with potential for adaptation to the Australian context.

On the basis of this process, 29 literacy and thirty numeracy tools were included in the subset. See Tables 2 and 3 following.

A description of each of the tools included in the subset is provided in Appendix 2. Tool descriptions were developed from a combination of information drawn from the web and manuals where direct access to tools was possible. Publication details appear in the Bibliography.

Table 2 Literacy diagnostic tools – selected subset

Literacy tools
Alpha Assess
An Even Start #
Assessment of English in the Early Years of Schooling
Assessment of Student Competencies (ASC)#
Assessment Resource Banks: English*
Assessment Tools for Teaching and Learning asTTle*#
Best Start Kindergarten Assessment#
Burt Word Reading Test
Developmental Assessment Resource for Teachers (DART) English
EQAO Assessments
First Steps: Literacy
Indigenous Preschool Profile#
Informal Prose Inventory (IPI)
Kindergarten and Pre-primary Profile#
Kindergarten Development Check#
K-7 Literacy Net
National Assessment Program Literacy and Numeracy (NAPLAN)#
National Education Monitoring Project (NEMP)*
Neale Analysis of Reading Ability
Observation Survey of Early Literacy Achievement
On Demand Tests Literacy#
Ontario Secondary School Literacy Test (OSSLT)
Performance Indicators in Primary Schools (PIPS)# (Reading and Phonological Awareness)
Progressive Achievement Tests (PAT-R)
QuickSmart and The Cognitive Aptitude Assessment System
School Entry Assessment (including the Anangu Schools Overlay)#
Supplementary Test of Achievement in Reading (STAR) *
Tests of Reading Comprehension (TORCH and TORCH Plus)
Year 2 Diagnostic Net#

* tools not used in Australia
# tool that also appear in the literacy selected subset

Table 3 Numeracy diagnostic tools – selected subset

Numeracy tools
An Even Start #
Assessment for Common Misunderstandings
Assessment of Student Competencies (ASC)
Assessment Tools for Teaching and Learning asTTle*#
Cognitive Diagnostic Assessment Tasks (CDAT)
Diagnostic Interview
Diagnostic Mathematical Tasks
Early Years Numeracy Interview
Elementary Math Mastery
Error Analysis Diagnosis in Mathematics (EADIM)
First Steps in Mathematics
Fractions and Decimals On-line Interview
Grade 9 Assessment of Mathematics Ontario*
I Can do Maths
Indigenous Pre-school Profile#
KeyMath-R
Kindergarten and Pre-primary Profile#
K-7 Numeracy Net
Mathematics Developmental Continuum P-10
Maths Online Interview
National Assessment Program Literacy and Numeracy (NAPLAN)# (incl Data Service & SMART)
On Demand Testing Numeracy#
One Minute Tests of Basic Number Facts
Performance Indicators in Primary Schools (PIPS)#
Progressive Achievement Tests (PAT-M)
QuickSmart and The Cognitive Aptitude Assessment System (CAAS)
Scaffolding Numeracy in the Middle Years
Schedule for Early Number Assessment (SENA 1 and SENA 2)
School Entry Assessment (including the Anangu Schools Overlay)#
Year 2 Diagnostic Net #

* tools not used in Australia
# tool that also appear in the literacy selected subset

5. EVALUATING LITERACY TOOLS

This chapter explores and evaluates the subset of literacy diagnostic tools. Two perspectives are provided:

- the reach or 'scope' of the tool in relation to student engagement, ease of use by teachers, support for intervention, and information for parents (four of seven criteria stipulated in the project brief); and
- the diagnostic capacity or 'power' of the instrument—a perspective that draws on the three remaining criteria stipulated in the project brief.

The evaluations are structured as follows:
The tools are grouped by the three school phases of special interest: Early Years (School Entry to Year 4), Transition Years (Years 5-8), and Year 9. A final section provides an overall picture raising issues across the literacy and numeracy divide.

Within each of the three groups the evaluations of the diagnostic power of the instruments used to collect evidence of students' knowledge, skills and understanding are set in the context of the tool descriptions. The set of evaluations (both the perspectives on the scope of the tools and the diagnostic power of the instruments) provides the research evidence from which conclusions and recommendations are drawn.

In considering the conclusions and recommendations it is important to note two limitations to the depth of the evaluations. First, not all tools were examined directly. In some instances researchers relied on web information (including a limited research review) supplemented by discussion with experts. It is possible therefore that the qualities of some tools have been over or underestimated. Second, where instruments were described as measurement instruments their underpinning psychometric properties were not interrogated.

Group 1 Early Years Tools

The literacy components of the diagnostic tools used with children in the Early Years of schooling (School entry to Year 4) are included in this group. Table 4 below shows the tools; the states/territories in which they are used; and the Year levels addressed. The tools are listed alphabetically in two separate sections of the Table. The upper section cites those tools used only in the Early Years; the lower section cites tools that are used across a number of years of schooling but that include an Early Years component.

A prose description of each of the tools can be found in Appendix 2. References for each tool are listed in the Literacy section of the Bibliography.

Table 4 Early Years Tools

Tool – Early Years only	**State/territory**	**Year level**
Assessment of English in the Early Years of Schooling	Vic	Before Year 1
Assessment of Student Competencies (ASC)	NT	Before Year 1
Best Start Kindergarten Assessment	NSW	Before Year 1
Indigenous Preschool Profile	Qld Tas Vic WA	Before Year 1
Kindergarten Development Check	Tas	Before Year 1
Kindergarten and Pre-primary Profile	WA	Before Year 1
Observation Survey of Early Literacy Achievement (Concepts about Print)	NSW SA Vic	First Year of schooling (Before Year 1)
Performance Indicators in Primary Schools (PIPS) (Reading and Phonological Awareness)	ACT Tas WA (school entry) and some NSW, NT, SA, Qld and Vic schools	First Year of formal schooling
School Entry Assessment (SEA)	SA	First Year of schooling
Year 2 Diagnostic Net	Qld	Multiple early years
Early Years component		
An Even Start	All	Years 3, 5, 7 & 9
AlphaAssess	WA (AIS)	Early Years through Middle Years
Assessment Resource Banks: English	NZ	Years 3-10
asTTle	NZ	Years 4-12
Burt Word Reading Test	WA (AIS) NZ, Britain, other Commonwealth countries	Between 6 years and 13 years of age
DART	SA	Years 3-5 and 6-8
EQAO assessments in reading, writing and mathematics (Primary 1-3, Junior 4-6)	Ontario, Canada	Years 1-3 and 4-6
First Steps	NT and Qld; First Steps Literacy used in SA and First Steps Map of Development – Reading Writing in WA USA, UK, New Zealand, Canada	Years K-7 and 6-12
Informal Prose Inventories (IPI)	NZ, Australia and overseas	Reading age 6-15 years
K-7 Literacy Net	WA	Years K-7
NAPLAN	Australian National	Years 3, 5, 7, 9
Neale	SA, Qld	6 years - 12 years 11 months of age
On Demand Tests: Literacy	Vic	School entry-Year 10
PAT-R	Qld, Tas, SA, WA	Years 1-10 (Comp.) Years 2-10 (Spelling) Years 3-10 (Vocab.)
Supplementary Test of Achievement in Reading (STAR)	NZ	Years 3, 4-6 and 7-9
TORCH and TORCH Plus	Qld, SA, WA	Years 3-10

Focus of the tools and instruments

Tables 5 and 6 provide an overview of the skills addressed by each instrument/tool based on the research evidence, that underpins reading. That is, phonemic awareness, phonics, fluency, vocabulary knowledge and text comprehension. The first four of these skills are sometimes considered to be precursors ('pre-reading skills') to text comprehension, although text comprehension in the context of early reading is not well defined. Table 5 cites Early Years only instruments/ tools; Table 6 instruments/ tools with an Early Years component.

Tables 7 and 8 provide an overview of writing skills addressed by instruments/tools that contain a writing component. Only the instruments/tools designed for use post school-entry assess writing directly.

A number of the instruments/tools address additional capabilities for reading (e.g. five assess Concepts of Reading or Print) and skills in addition to reading and writing. For example, five assess Speaking. The most divergent of the tools is the *Kindergarten Development Checklist* (KDC) which comprises a comprehensive assessment of oral language at pre-reading level including the following indicators: Talks fluently without stuttering; Uses normal voice and pitch; Speaks in a manner that can be easily understood by adults; and Recounts a personal experience in logical sequence.

All the diagnostic instruments/tools in Group 1 (except for *An Even Start*) are intended to provide baseline information on students' literacy knowledge, skills and understandings. The majority of instruments rely on teachers' direct observations of students at work. All are linked directly to Australian system-based curriculum standards apart from *PIPS*. However, Tasmania has successfully mapped *PIPS* against its curriculum.

With the caution that the instruments/tools are used with students across several Year levels, it is possible to make some tentative observations. From Table 5 it can be seen that only two of the reading instruments/tools assess all five of the essential capabilities derived from research literature: *Assessment of English in the Early Years of Schooling* and *An Even Start*. Phonics and Phonemic Awareness are the most frequently assessed capabilities, text comprehension the least. The limited focus on text comprehension may not be a surprise, given that all but two of the Early Years instruments/tools cited here are used at school entry or during the first year of schooling. Table 7 shows slim coverage of writing. Only two instruments/tools address writing skills in any comprehensive way and these are the instruments that are used with students beyond school entry. Again this may not be a surprise.

Table 5 Focus of Early Years only Reading Instruments/tools

Instrument	Essential capabilities derived from research literature					Additional reading skills	
	Phonemic Awareness	Phonics	Fluency	Vocab. Knowl.	Text Comp.	Concepts about Reading/ Print	Other
Assessment of English in the Early Years of Schooling	✓	✓	✓	✓	✓		
Assessment of Student Competencies (ASC)		✓				✓	Identify own name in print Use illustrations to make meaning
Best Start Kindergarten Assessment	✓	✓				✓	Recall details about a picture story book read by others
Indigenous Preschool Profile						✓	Recognise own name in print; link between experience, oral language and written text
Kindergarten Development Check							Identify own name in print
Kindergarten and Pre-primary Profile Package					✓	✓	
Observation Survey of Early Literacy Achievement	✓	✓	Word reading			✓	
Performance Indicators in Primary Schools (PIPS)	✓	✓	✓	✓		✓	
School Entry Assessment (SEA)	✓						
Year 2 Diagnostic Net				Make meaning at word level	✓		Attitude to Reading

Table 6 Focus of Reading Instruments/tools with an Early Years component

Instrument	Essential capabilities derived from research literature					Additional reading skills	
	Phonemic Awareness	Phonics	Fluency	Vocab. Knowl.	Text Comp.	Concepts about Reading/ Print	Other
Alpha Assess	✓	✓	✓	✓	✓		High freq. words, random letter identification
An Even Start	✓	✓	✓	✓	✓		
Assessment Resource Banks *			✓	✓	✓		Thinking about how language works
asTTle *		Knowledge of grapho-phonic cues		✓	✓		Attitude, exploring lang., thinking critically, processing info, analysing writing conventions
Burt Word Reading Test			✓	✓	✓		Word recognition and decoding
DART					✓		
EQAO*					✓		
First Steps	✓	✓	✓	Making mean. at word level	✓		Attitude
IPI			✓		✓		Miscue analysis
K-7 Literacy Net				Making mean. at word level	✓		Attitude
Neale Analysis of Reading Ability	✓	✓	✓		✓		
On Demand Tests: Literacy				✓	✓		
PAT-R				✓	✓		
STAR				✓	✓		
TORCH and TORCH plus					✓		

* Tool not used in Australia

Table 7 Focus of Early Years only Writing Instruments/tools

Instrument	Skills Addressed							
	Letter / word writing	Concepts of writing	Ideas/ content	Vocab. and word usage	Spelling	Punct.	Grammar and sentence control	Additional writing skills
Assessment of English in the Early Years of Schooling	Own name			✓				Reading back own writing, relevance of own writing to a story read aloud
Assessment of Student Competencies (ASC)	Use copied symbols and some letters	✓	Through drawings, copied symbols and some letters					
Best Start Kindergarten Assessment	Own name							
Indigenous Preschool Profile	Letters							
Observation Survey of Early Lit. Achievement				✓				
Performance Indicators in Primary Schools (PIPS)	Own name							
School Entry Assessment	✓	✓			✓	✓	✓	
Year 2 Diagnostic Net			✓	✓	✓	✓	✓	Organisation and contextual understandings; attitude

Table 8 Focus of Writing Instruments/tools with an Early Years Component

Instrument	Skills Addressed							
	Letter / word writing	Concepts of writing	Ideas/ content	Vocab. and word usage	Spelling	Punct.	Sentence control/ grammar	Other writing skills
Alpha Assess			✓					Written language, text conventions, organisation, mechanics
An Even Start			✓	✓	✓	✓	✓	
Assessment Resource Banks*			✓	✓	✓	✓	✓	
asTTle*			✓		✓	✓	✓	Audience awareness
DART			✓		✓	✓	✓	
EQAO*			✓		✓	✓	✓	Organisation
First Steps					✓	✓	✓	Different purposes
K-7 Literacy Net			✓	✓	✓	✓	✓	Organisation
NAPLAN			✓	✓	✓	✓	✓	
On Demand Testing Literacy					✓	✓	✓	

* Tool not used in Australia

Evaluation of the Instruments/tools

Two evaluation perspectives are provided as a basis for discussion, reflection and recommendations:

- comparison of the instruments/tools using the framework of seven quality criteria with an emphasis on those criteria that relate to *engagement*, *ease of use for teachers*, *support for intervention*, and *communicating with parents*; and
- evaluations of the diagnostic power of each instrument.

An example of evaluations against the seven quality criteria appears in Appendix 4. The evaluations of the diagnostic power of each instrument/tool were determined by aggregating the evaluations of the three quality criteria that address diagnostic capacity (see Chapter 3, Defining Quality Tools).

In addition to these two perspectives, consideration is given to the relationship between school entry instruments/tools and the AEDI.

Seven quality criteria

Recognising that the tools and instruments designed for use with the youngest of students cannot focus on some skills, almost all of the tools used in the Early Years only meet the seven quality criteria to a large extent or to a moderate extent (that is, moderate but adequate) for reading. Few tools assess writing. Some instruments focus on conceptual underpinnings

as well as skills including *Best Start*, *School Entry Assessment*, *An Observation Survey of Early Literacy Achievement and Concepts About Print*.

A number of tools and instruments are minimal in the support they provide for teachers such as assisting teachers to understand what the tool is measuring; extra advice for administration with specific groups; strategies for teachers to address individual student needs; and accurate information on expected outcomes of suggested strategies that are aligned with international research evidence.

A number of tools and instruments state explicitly that they provide teaching strategies or resources to address the gaps identified by the assessments: *Assessment of Student Competencies*, *Best Start*, *Kindergarten Development Check*, the *Year 2 Diagnostic Net* and *An Even Start*.

A very small number of tools provide information on use with particular groups of students. Information specific to Indigenous students is provided by the Indigenous Preschool Profile, the *Assessment of Student Competencies* and the *School Entry Assessment*.[10] These tools address provision in different ways. For example, the *School Entry Assessment* provides information specific to Indigenous students in the Anangu Schools Overlay. This overlay is identical to the main instrument in terms of the stages of development that are outlined, and the kinds of evidence that might exemplify progression through the stages. The difference lies in the presumption that students' learning will be more effective if they are able to experiment with new concepts in their own context and language. Each stage of development is therefore considered in terms of whether the student can demonstrate their understanding first using their home and community language, second by responding to English and third using English.

Only two of the tools and instruments provide information in a form that would be valued by parents to a high degree: *PIPS*, and the *Year 2 Diagnostic Net*. (See also Chapter 7.)

Of the tools that contain an Early Years component only four instruments meet all seven criteria to a large or moderate extent: *NAPLAN*, *An Even Start*, *PAT-R* and *TORCH* (all of which have been designed to do so). Those that meet the criteria least well overall are the New Zealand *NEMP*, *Curriculum Exemplars*, *Neale Analysis of Reading* and the *Burt Reading Test*. The latter two intentionally focus on a very narrow aspect of reading.

Diagnostic power

The selected Early Years only tools and instruments have varying degrees of diagnostic power. The tools and instruments with the most diagnostic power; that is, the tools and instruments that produce the most fine-grained diagnostic information are the *Assessment of English in the Early Years of Schooling*, the *Assessment of Student Competencies* and *PIPS*. Of the tools that contain an Early Years component, three instruments provide the most diagnostic power: *An Even Start*, *PAT* and *TORCH* although the latter two do so in relation to one aspect of reading (reading comprehension). When *NAPLAN SMART* is used in conjunction with the *NAPLAN* instrument, the power of the instrument is increased substantially. Although the asTTle provides detailed diagnostic information, the skills addressed do not match the underpinning skills defined by research as well as some other instruments.

[10] It is assumed that in the development of materials explicit consideration is given to contexts that are appropriate and engaging to diverse communities.

Two challenges particular to the quality of information gained from frameworks and checklists are noted. The first is the extent to which these tools are sufficiently fine-grained. The second is that the extent to which it is possible for teachers to observe behaviours is dependent on a rich environment, the observation skills and recording strategies that a teacher has mastered, and the ability of a teacher to make an on-balance judgement of observed behaviour and draw an inference back to framework levels. Thus the use of a framework or checklist has only the *potential* to provide information of high diagnostic power.

Additional considerations
Three Early Years only tools and instruments include attractive features that are worth noting in the development of any new diagnostic tools materials.

PIPS is supported by a CD-ROM based adaptive program. An audio track delivers each question and the student responds by pointing to the screen or talking to the teacher who enters the student's response. This feature may be particularly engaging for young students. In addition, PIPS has a very fast data turnaround via the *AusPIPS* website, a secure website for submitting data and viewing feedback online.

The *Assessment of English in the Early Years of Schooling* is an online delivery tool with group administered writing. This may be particularly attractive to teachers.

The *Year 2 Diagnostic Net* relies on teacher judgement in the collection of evidence of learning, as do most of the Early Years Tools evaluated. The Net, however, includes special validation tasks to support teacher judgements. These tasks will support the reliability of teacher judgements and may be particularly attractive to teachers.

The Australian Early Development Index (AEDI)
The AEDI provides an additional context for the early years diagnostic tools.

The AEDI is designed to derive a population level measure of children's development by the time they reach school age. For each child in their first year of full-time school teachers complete a checklist comprising about 100 questions that address five developmental areas:

- physical health and wellbeing;
- social knowledge and competence;
- emotional health and maturity;
- language and cognitive development; and
- communication skills and general knowledge.

A more detailed overview of the AEDI can be found in Appendix 3.

Two of the AEDI developmental areas are relevant to this study: language and cognitive development; and communication skills and general knowledge.

The *Language and Cognitive Skills* checklist assesses students' interest in reading and writing; age-appropriate reading and writing; and numeracy skills (including ability to recite specific pieces of information from memory, to understand similarities and differences, to count, to recognise numbers and shapes and to play board games).

The *Communication skills and general knowledge* checklist assesses students' ability to tell a story; to communicate with adults and children, including communicating needs and wants in socially appropriate ways; to use symbolic language; to tell stories; and to demonstrate age-appropriate knowledge about life and the world.

These AEDI checklists provide literacy information of varying degrees of specificity and diagnostic power. For example, knowing whether a child's reading achievement is within age expectation is useful information, but only a first step to diagnosing strengths and weaknesses. (Indeed, the AEDI information makes explicit that it is not a diagnostic tool for individual students.) Teachers will need to use additional tools establish sources of literacy and numeracy difficulty. The Early Years diagnostic tools provide, for example, some of the 'drill down' information that assists teachers to focus their attention on specific gaps in reading and writing knowledge, skills and understandings.

Reflections

1 reading

Children enter school with widely varying capabilities and levels of readiness for formal learning. They vary greatly in their analytical and strategic tools, and in their dispositions to take on the ethos, culture and pedagogic routines of the classroom (Louden et al., 2005). They enter with different levels of cognitive and language development, numeracy understandings, and social, emotional and psychomotor skills. They come with varying 'funds of knowledge' that prepare them differentially for the language and literacy environments of school (Hill et al., 1998) and they come with prior knowledge that can facilitate or sometimes impede formal learning (Bransford et al., 2000). [11]

Many students can read when they come to school and a significant number of students are still mastering early reading skills in Year 3. Research evidence suggests that this 'within-grade' variability in children's development, at least in the context of reading and mathematics achievement, widens as children progress through school (Rowe & Hill, 1996; Harlen, 1997; Hauser, 2003). Of the examined Early Years tools most school entry instruments focus on early reading skills, and most tools used beyond school entry focus primarily on comprehension. Consideration might be given to including a greater emphasis on the assessment of reading comprehension for school entry instruments and a greater emphasis on specific reading skills for Year 3 students.

2 writing and oral language

A number of tools emphasise the role of oral language in the early years. Few address a range of writing skills. We now have clear research evidence on the nature of early reading skills and therefore, a research-based focus for reading assessment. There is less comprehensive evidence for underpinning oral language and writing skills. Consideration could be given to a national review of oral language and writing teaching that would complement the National Reading Review.

3 monitoring learning

The National Inquiry into the Teaching of Literacy (Reading) recommended the measurement of individual students' progress in literacy by regularly monitoring the development of each

[11] The Queensland Government Early Years Curriculum guidelines (September 2005) provide a useful discussion of learning and development phases on school entry. 'Prepared for Kindergarten: What does Readiness Mean? Ackermann and Barnett pp.4-8 looks at an international perspective.

child and reporting progress twice each year for the first three years of schooling. None of the instruments cited could be used for this purpose.

Group 2 Transition Years and Year 9 Tools

The literacy components of the diagnostic tools used with students in the Transition Years of schooling (Years 5-8) and Year 9 are included in this group. Table 9 below shows the tools; the states/territories in which they are used; and the Year levels addressed. The tools are listed alphabetically in two separate sections of the Table. The upper section cites those tools used only in the Transition Years and Year 9; the lower section tools that are used across a number of years of schooling but that include Transition Years and Year 9 components. A prose description of each tool can be found in Appendix 2. References are listed in the Bibliography.

Table 9 Transition Years and Year 9

Tool – Transition Years and Year 9 only	**Aust State/territory or Country**	**Year level**
National Education Monitoring Project (NEMP)	New Zealand	Year 4 and Year 8
Ontario Secondary School Literacy Test (OSSLT)	Canada	Year 9
QuickSmart and The Cognitive Aptitude Assessment System	NSW, NT, ACT, Vic and SA	Transition years (Years 5, 6, 7, 8)
Transition Years and Year 9 component		
AlphaAssess	WA (AIS)	Early Years through Middle Years
An Even Start	All	Years, 3, 5, 7, 9
Assessment Resource Banks: English	NZ	Years 3-10
asTTle	asTTle	Years 4-12
Burt Word Reading Test	WA (AIS) NZ, Britain, other Commonwealth countries	For students between 6 years and 13 years of age
DART	SA	Years 3-5 and 6-8
EQAO assessments in reading, writing and mathematics (Primary 1-3, Junior 4-6)	Ontario, Canada	Years 1-3 and 4-6
Informal Prose Inventories (IPI)	NZ, Australia and overseas	Students at reading age 6 to 15 years
NAPLAN	Australian National	Years 3, 5, 7, 9
Neale	SA, Qld	6 years to 12 years 11months of age
On Demand Testing Literacy	Vic	School entry-Year 10
PAT-R	Qld, Tas, SA, WA	Years 1-10 (Comp.) , Years 2-10 (Spelling) Years 3-10 (Vocab.)
Supplementary Test of Achievement in Reading (STAR)	NZ	Years 3, 4-6 and 7-9
TORCH and TORCH Plus	Qld, SA, WA	Years 3-10

Focus of the instruments

Table 10 below shows the reading skills addressed by the instruments used in the Transition Years and Year 9 only, and tools that include a Transition Years and/or Year 9 component.

Only three instruments are specific to the Transition Years and Year 9. The *OSSLT* focuses on reading comprehension: understanding of directly and indirectly stated ideas and information; and making use of connections between personal knowledge and experience and the ideas and information in the reading selections (e.g. interpretation of meaning) using a range of text types. *NEMP* includes the assessment of strategies including making use of semantic, syntactic and visual cues in text, making use of grapho-phonic and word level strategies, making self-corrections and using and expanding word knowledge.

The assessment instrument (*The Cognitive Aptitude Assessment System*) developed for the *QuickSmart* intervention program focuses on basic knowledge and understandings that can equip students with the skills necessary to engage more successfully with classroom instruction: word recognition; vocabulary knowledge; reading fluency; and comprehension strategies.

Two of these tools, *NEMP* and *OSSLT* address writing. In the *OSSLT*, the writing tasks assess the development of a main idea; provision of supporting details; organisation and linking of ideas and information; the use of an appropriate tone for the purpose and the intended reader; and the use of correct grammar, punctuation, and spelling. The range of contexts includes a summary, a series of paragraphs expressing an opinion, a news report, and an information paragraph. *NEMP* writing focuses on the *processes* of planning, composing, editing and presenting.

The tools that contain a Transition Years and/or Year 9 component range from tools that focus on a single narrowly defined skill such as the *Burt Word Reading Test* to tools that address a range of essential capabilities derived from research literature. A number of the tools focus primarily on Text Comprehension (literacy and inferential information including, for example, identifying the main idea and inferring the meaning of a work from the context) which is not unexpected given the assumption that the majority of students at this stage of their schooling would be fluent readers.

Table 11 shows the writing skills addressed by the instruments used in the Transition Years and Year 9 only, and tools that include a Transition Years and/or Year 9 component. Instruments that do not contain a writing component are excluded.

The instruments in this set are almost entirely consistent in the range of writing skills they address—although these skills are not always categorised by the same wording as the Table headings. Exceptions are the *PAT-R*, which focuses on a single writing skill (spelling) rather than a range of skills; and the focus of instruments designed for lower secondary rather than upper primary grades. These instruments do not address vocabulary and word usage as separate skills.

Table 10 Focus of Transition Years and Year 9 Reading instruments

Instrument	Essential capabilities derived from research literature					Additional reading skills	
	Phonemic Awareness	Phonics	Fluency	Vocab. Knowl.	Text Comp.	Concepts about Reading/ Print	Other
Transition Years and Year 9 only							
NEMP *		✓	✓	✓	✓		
Ontario Secondary School Literacy Test (OSSLT)*					✓		
QuickSmart and The Cognitive Aptitude Assessment System			✓	✓	✓		Simple and middle word recog.; non-word reading tasks
Transition Years and Year 9 components							
AlphaAssess	✓	✓	✓	✓	✓	✓	High frequency words, random letter identification
An Even Start	✓	✓	✓	✓	✓		
Assessment Resource Banks: English*			✓	✓	✓		Thinking about how language works
asTTle*		Grapho-phonic cues knowl.		✓	✓		Attitude, Exploring Language, Thinking critically, processing info.
Burt Word Reading Test							Word recognition and decoding
DART					✓		
EQAO *					✓		
Informal Prose Inventories (IPI)			✓		✓		Miscue analysis
NAPLAN			✓	✓			
Neale	✓	✓	✓		✓		
On Demand Tests: Literacy				✓	✓		
PAT-R				✓	✓		
STAR*				✓	✓		
TORCH					✓		

* Tool not used in Australia

Table 11 Focus of Transition Years and Year 9 Writing instruments

Instrument	Skills Addressed						
	Structure of ideas; coherence	Ideas; content	Vocab. word usage	Spell.	Punct.	Grammar; sentence control	Other writing skills
Transition Years and Year 9 only							
NEMP *	✓	✓ Including creativity/ originality	✓	✓	✓	✓	Planning, composing, editing, presenting; handwriting
Ontario Secondary School Literacy Test (OSSLT)*	✓	✓		✓	✓	✓	
Transition Years and Year 9 components							
An Even Start			✓	✓	✓	✓	
Assessment Resource Banks: English*	✓	✓	✓	✓	✓	✓	
asTTle*	✓	✓	✓	✓	✓	✓	Audience awareness and purpose
DART	✓	✓		✓	✓	✓	
EQAO	✓	✓		✓	✓	✓	
NAPLAN	✓	✓	✓	✓	✓	✓	
On Demand Testing Literacy			✓				
PAT-R				✓			

* Tool not used in Australia

Evaluation of the Instruments/tools

Two evaluation perspectives are provided as a basis for discussion, reflection and recommendations:

- comparison of the instruments/tools using the framework of seven quality criteria with an emphasis on those criteria that relate to *engagement*, *ease of use for teachers*, *support for intervention*, and *communicating with parents*; and
- evaluations of the diagnostic power of each instrument.

An example of evaluations against the seven quality criteria appears in Appendix 4. The evaluations of the diagnostic power of each instrument/tool were determined by aggregating the evaluations of the three quality criteria that address diagnostic capacity (see Chapter 3, Defining Quality Tools).

Seven Quality Criteria

The three tools specific to the Transition Years and Year 9 assess very different aspects of literacy learning, and support users in very different ways. For example, unlike many tools, the *OSSLT* suite provides considerable support for teachers *and* students to understand what is being addressed via an extensive website that includes detailed instructions for 'Students with Special Education Needs and English Language Learners', planning and preparation guides for teachers and sample test materials to discuss with students. In contrast, only one piece of

QuickSmart, The Cognitive Aptitude Assessment System has the support of a comprehensive intervention program.

Given that the tools that include a Transition Years and Year 9 component are designed for very different purposes and audiences, it is not surprising that overall very few of the tools provide strategies for teachers to address students' needs; and a number do not provide information for reporting to parents. Only two tools rate highly (on-balance) across all the seven criteria: *NAPLAN* (particularly when used in conjunction with a package like the NSW *SMART NAPLAN*[12]) and *An Even Start*. Both of these assessments were designed to address a number of the specified criteria.

Diagnostic power of the instruments

The *OSSLT* and *NEMP* explicitly exclude providing detailed information about an individual's strengths and weaknesses. However, given the range of skills assessed explicitly, the raw data about an individual student could be used by the school as a basis for investigating gaps in students' literacy skills (noting that in the case of OSSLT, feedback on individuals' strengths and weaknesses is limited to item level information for students who fail the test).

Only three of the tools that contain a Transition Years and/or Year 9 component range are evaluated at the highest level of diagnostic power: the *Burt Word Reading Test*, and the *Neale Analysis of Reading Ability* and *PAT-R*. The first two are narrowly focused on word recognition skills, the last on reading comprehension.

Additional considerations

Three tools have distinctive features that might be considered in the development of new diagnostic resources.

The New Zealand *NEMP* materials have a different emphasis in their conceptualisation from other tools. For example, many process skills (such as the editing of writing) are addressed. Although outside the considerations of this study, *NEMP* includes a comprehensive set of listening and viewing assessments that can be administered one-on-one or in a group of four students who work co-operatively. If the new Australian national curriculum shifts its emphasis from that of current state/territory frameworks, *NEMP* may provide a model for the assessment of 'additional' literacy skills.

The New Zealand *asTTle* resource has a very large item bank (4000 items) that allows teachers to custom-create tests. In the case of writing, exemplars enhance the reliability of marking. In the case of reading, skills include: exploring language, thinking critically and processing information. If the new Australian national curriculum shifts its emphasis from that of current state/territory frameworks *asTTle* may provide a model for the assessment of 'additional' reading skills.

The *Developmental Assessment Resource for Teachers* (*DART*) provides a thematic context for the assessment of reading, writing, speaking, listening and viewing. This provides teachers with the opportunity to embed assessments in a curriculum context.

[12] The SMART NAPLAN package is a software package that assists teachers to analyse their students' NAPLAN results. See also Numeracy Evaluations.

Reflections

The evaluation of the tools used in the Transition Years and Year 9, and those that have a Transition Years and/or Year 9 component raises two issues.

1 skills underlying reading comprehension

While four of the five skills that underpin early reading are well defined and articulated consistently in the research literature, there is less explicit agreement about the skills that are fundamental to 'reading comprehension'. This presents an evaluation challenge for this study. Different instruments focus on different aspects of reading comprehension. Sometimes these aspects are made explicit, often not. Sometimes they can be inferred from achievement reports where 'descriptors' of the skills addressed by each item are provided.

It would be helpful for teachers, if the reading comprehension skills that students are expected to develop as they move through the Transition Years of school (and beyond) were clarified. One perspective could come from a comparison of the set of skills made explicit in the new national curriculum; the *NAPLAN*; the *Program for International Student Assessment* (*PISA*); and the *Progress in International Reading Literacy Study* (*PIRLS*). This is not to suggest that the skills of each instrument should be the same—the skill set made explicit in the new national curriculum is likely to be more extensive than that addressed by NAPLAN—but that there should be some consistency. Another more curriculum-based perspective could come from a national inquiry into the teaching of reading comprehension. This would complement and extend the 2005 National Inquiry into the Teaching of Literacy (Reading), which focused on early reading.

2 a Transition Years and Year 9 focus

The second issue relates to an intended focus of the study on the Transition Years and Year 9. Bearing in mind the limitations of the methodology, only one Australian tool developed specifically for the Transition Years was cited, and none for Year 9 were cited. This raises a question about the necessity for specific tools and/or instruments for students in these year levels. Intuition suggests an important consideration may be that of engagement, particularly the engagement of low achieving students, although no evidence for or against this intuition has been exposed in this study.

6. EVALUATING NUMERACY TOOLS

This chapter explores and evaluates the subset of numeracy diagnostic tools. Two perspectives are provided:

- the reach or 'scope' of the tool in relation to student engagement, ease of use by teachers, support for intervention, and information for parents (four of seven criteria stipulated in the project brief); and
- the diagnostic capacity or 'power' of the instrument—a perspective that draws on the three remaining criteria stipulated in the project brief.

As noted in the preface to the Literacy Evaluations, the evaluations are structured as follows: The tools are grouped by the three school phases of special interest: Early Years (School Entry to Year 4), Transition Years (Years 5-8), and Year 9. A final section provides an overall picture, raising issues across the literacy and numeracy divide.

Within each of the three groups the evaluations of the diagnostic power of the instruments used to collect evidence of students' knowledge, skills and understanding are set in the context of the tool descriptions. The set of evaluations (both the perspectives on the scope of the tools and the diagnostic power of the instruments) provides the research evidence from which conclusions and recommendations are drawn.

In considering the conclusions and recommendations it is important to note two limitations to the depth of the evaluations. First, not all tools were examined directly. In some instances researchers relied on web information (including a limited research review) supplemented by discussion with experts. It is possible therefore that the qualities of some tools have been over or underestimated. Second, where instruments were described as measurement instruments their underpinning psychometric properties were not interrogated.

Group 1 Early Years Tools

Twenty-three diagnostic tools used with children in the Early Years of schooling are included in this group. Table 12 below provides an alphabetical listing of the tools; the states/territories in which they are used; and the year levels addressed. The upper section of the Table cites those tools used only in the Early Years; the lower section cites tools that are used across a number of years of schooling but that include an Early Years component. A prose description of each of the tools evaluated in Group 1 can be found in Appendix 2. References for each tool are listed in the Numeracy section of the Bibliography.

Table 12 Early Years Tools

Tool Early Years only	**State/territory**	**Year level**
Assessment of Student Competencies (ASC) #	NT	Before Year 1
I Can Do Maths	Vic	Before Year 1
Indigenous Preschool Profile #	Qld Tas Vic WA	Before Year 1
Kindergarten and Pre-primary Profile Package#	WA	Before Year 1
Performance Indicators in Primary Schools (PIPS)#	ACT Tas WA (some NSW, NT, Qld, SA, and Vic schools)	First Year of formal schooling
Schedule for Early Number Assessment (SENA)	ACT, NSW, NT	SENA 1 – K-1 SENA 2 – Year 2-3
School Entry Assessment (SEA) (including the Anangu Schools overlay)#	SA	First Year of formal schooling
Year 2 Diagnostic Net #	Qld	Multiple early years
Early Years component	**State/territory**	**Year level**
An Even Start#	All Australian	Year 3, 5, 7 & 9
Assessment for Common Misunderstandings	Vic	Prep to Year 8
Assessment Tools for Teaching and Learning asTTLe#	New Zealand	
Cognitive Diagnostic Assessment Tasks (CDAT)	Qld	Years 1-5
Diagnostic Mathematical Tasks		Prep to Year 6
First Steps in Mathematics	NT, Qld, Tas, Vic, WA,	Age 3 years to 13 years
KeyMath-R	USA	K – Year 9
K-7 Numeracy Net	WA	K-7
Mathematics Developmental Continuum	Vic	P-10
Maths Online Interview	Vic	First Year of school to Year 4
National Assessment Program Literacy and Numeracy (NAPLAN)# (including the Data Service & SMART)	All Australian states and territories	Year 3, 5, 7 & 9
Diagnostic Interview	New Zealand	First year - Grade 6
On Demand Testing: Numeracy	Vic	Years 3-8
One Minute Tests of Basic Number Facts	All states	6-11 year olds
Progressive Achievement Tests (PAT-M)	Qld, SA, Tas, WA	Years 2-10 or Years 3-11 depending on jurisdiction

Tool includes a literacy component

Focus of the Tools

The diagnostic 'tools' used with children in the Early Years of schooling vary widely in their conceptualisation. Some are instruments—vehicles through which evidence of learning is collected and assessed. Some are developmental frameworks comprising described levels of achievement against which teachers make on-balance judgements on the basis of observations or evidence from instruments of their choice. Some are instruments only (narrowly or broadly defined), and some tools are designed as comprehensive packages that include a range of support materials for teachers. A few instruments are objective and reliable tests underpinned by modern measurement techniques that provide *measures* of achievement along empirically based measurement scales. Some tools are designed for teacher use only, others for communication with parents and students.

These differences in conceptualisation and intent are relevant to, and useful for, describing and comparing tools, but challenge the possibility of overall evaluation.

Focus of the Instruments

Table 13 provides a summary of the Number skills addressed by each instrument/tool. Note that Algebra is not addressed in the Early Years; and that Fractions are not addressed by those instruments used only at school entry.

Table 14 provides an overview of the Space, Measurement, and Working Mathematically skills, and Key Concepts, addressed by each instrument that addresses at least one of the named numeracy skills.

All the instruments/tools in Group 1 that are used only in the Early Years are intended to provide baseline information on students' numeracy knowledge, skills and understandings. The majority of instruments rely on teachers' direct observations of students as they work. On the basis of their observations teachers make an on-balance judgement of a child's achievement level with reference to the described levels along a provided framework. Apart from *PIPS* all these instruments/tools are linked directly to Australian system-based curriculum standards, and Tasmania has successfully mapped *PIPS* against its curriculum.

Five of these ten instruments/tools address the number skill areas: Counting, Place Value, Operations (whole number only) and Patterns and Relationships. Of these skill areas, Counting, Operations, and Patterns and Relationships are addressed by all but two instruments.

Of the additional ten instruments/tools that include an Early Years component all but one (the *One Minute Test of Basic Number Facts*) address the full range of skill areas. In addition to whole number counting operations, *NAPLAN* addresses fraction operations. *One Minute Test of Basic Number Facts* is a narrowly focused assessment that addresses whole number operations only.

When it comes to the mathematics strands of Space, Measurement, Chance and Data, and Working Mathematically, there is far less agreement on the skills that should be addressed. For example, only three of the ten instruments used only in the Early Years, address the complete set of strands. However, six of those ten are strongly underpinned by age and appropriate key concepts—sometimes thought of as the 'big ideas' in topic areas.

Table 13 Focus of Early Years Numeracy (Number) Instruments/tools

Instrument	**Number skills addressed**				
	Counting	Place value	Operations		Patterns and relationships
			Whole	*Fractions (incl. rational nos.)*	
Early Years only					
Assessment of Student Competencies (ASC)	✓				✓
Early Years Numeracy Interview P-4	✓	✓	✓		✓
First Steps in Mathematics	✓	✓	✓		✓
I Can Do Maths (P-2)	✓	✓	✓		✓
Indigenous Pre-school Profile	✓				✓
Kindergarten and Pre-Primary Profile Package including Numeracy Net	✓		✓		✓
Maths Online Interview P-4	✓	✓	✓		✓
PIPS	✓	✓	✓		
Schedule for Early Number Assessment (SENA)	✓	✓	✓		
School Entry Assessment (SEA)	✓	✓	✓		✓
Year 2 Diagnostic Net	✓	✓	✓		✓
Early Years component					
An Even Start	✓	✓	✓		✓
Assessment for Common Misunderstandings	✓	✓	✓		✓
Assessment Tools for Teaching and Learning (asTTle)*	✓	✓	✓		✓
Cognitive Diagnostic Assessment Tasks (CDAT)	✓	✓	✓		✓
Diagnostic Interview	✓	✓	✓		
Diagnostic Mathematical Tasks	✓	✓	✓		✓
KeyMath-R	✓	✓	✓		✓
Mathematics Developmental Continuum P-10	✓	✓	✓		✓
NAPLAN	✓	✓	✓	✓	✓
On Demand Testing: Numeracy	✓	✓	✓	✓	✓
One Minute Tests of Basic Number Facts			✓		
Progressive Achievement Tests (PAT-M)	✓	✓	✓		✓

*Tool not used in Australia

Table 14 Focus of Early Years Numeracy (Space, Measurement,Working Mathematically, and Key Concepts) Instruments

Instrument	Numeracy Skills Addressed					
	Space		Measure-ment	Chance and Data	Working Mathematically (examples)	Key Concepts
	Shape	*Locate*				
Early Years only						
Assessment of Student Competencies (ASC)	✓	✓	✓		1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.9	✓
Early Years Numeracy Interview P-4	✓		✓		1.1, 1.2, 1.7, 1.9	✓✓
First Steps Numeracy	✓	✓	✓	✓	1.1, 1.2, 1.4, 1.9	✓✓
I Can Do Maths (P-2)	✓		✓	✓	1.2, 1.5, 1.6	✓
Indigenous Pre-school Profile**		✓	✓		1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9	
Kindergarten and Pre-Primary Profile Package including Numeracy Net	✓	✓	✓	✓	1.1, 1.2, 1.9	✓
Mathematics Developmental Continuum P-10	✓	✓	✓	✓	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9	✓✓
Maths Online Interview P-4	✓				1.1, 1.2, 1.7, 1.9	✓✓
PIPS	✓		✓		*Items not available*	✓
Schedule for Early Number Assessment (SENA)					1.3 1.4 1.7 1.9	✓✓
School Entry Assessment (SEA)**	✓	✓	✓	✓	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9	✓✓
Year 2 Diagnostic Net					1.1, 1.3, 1.4, 1.5, 1.7	✓✓
Early Years component						
An Even Start	✓	✓	✓	✓	1.1, 1.2, 1.3, 1.5, 1.6, 1.9,	✓✓
Assessment for Common Misunderstandings	✓	✓	✓		1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.9	✓✓
Diagnostic Interview					1.2, 1.3, 1.6, 1.7, 1.9	✓
Diagnostic Mathematical Tasks	✓	✓	✓	✓	1.2, 1.3, 1.6	✓✓
Early Years Numeracy Interview P-4	✓		✓		1.1, 1.2, 1.7, 1.9	✓✓
First Steps in Mathematics	✓	✓	✓	✓	1.1, 1.2, 1.4, 1.9	✓✓
KeyMath-R	✓	✓	✓	✓	1.3, 1.6	✓
Maths Online Interview P-4	✓		✓		1.1, 1.2, 1.7, 1.9	✓✓
NAPLAN	✓	✓	✓	✓	1.2, 1.6	✓
Progressive Achievement Tests (PAT-M)**	✓	✓	✓	✓	1.2, 1.6	✓
PIPS	✓				*Items not available*	✓

✓✓= to a large extent
✓= to some extent underpinned by age and topic appropriate concepts
** = dependent on the classroom program being rich and educationally sound to provide opportunities for assessment in these areas.
Appendix 5 provides a list of the sub-skills (1.1-1.9) included under working mathematically in the Early Years.

Evaluation of the Instruments/tools

Two evaluation perspectives are provided as a basis for discussion, reflection and recommendations:

- comparison of the instruments/tools using the framework of seven quality criteria with an emphasis on those criteria that relate to *engagement*, *ease of use for teachers, support for intervention,* and *communicating with parents*; and
- evaluations of the diagnostic power of each instrument.

An example of evaluations against the seven quality criteria appears in Appendix 4. The evaluations of the diagnostic power of each instrument/tool were determined by aggregating the evaluations of the three quality criteria that address diagnostic capacity (see Chapter 3, Defining Quality Tools).

In addition to these two perspectives, consideration is given to the relationship between school entry instruments/tools and the AEDI.

Seven Quality Criteria

Taking into account that some tools are conceptualised as a suite of resources, most of the instruments cited address issues of engagement; ease of use and support for intervention; and communication with parents to at least a moderate and adequate extent. Six of the thirteen instruments are particularly strong on all but one criterion (the provision of information for the assessment of specific groups of students): *An Even Start,* and the *Early Years Numeracy Review*, *First Steps in Mathematics*, the *Maths Online Interview*, and *Schedule for Early Number Assessment*. The *Year 2 Diagnostic Net* also provides detailed instruction on inclusive practices to ensure that all students have the opportunity to show what they know and can do. The *Diagnostic Net* materials include a section on Aboriginal and Torres Strait Islander students; students with hearing, vision and physical disabilities; students who are speech impaired, have learning difficulties, or for whom English is a second language; gifted and talented students; isolated students; and students from a low socioeconomic background.

Diagnostic power of the instruments

Most of the instruments cited address the criteria related to diagnostic power to at least a moderate (and adequate) extent. Four of the thirteen instruments are particularly strong on all criteria related to diagnostic power: *An Even Start,* the *Early Years Numeracy Review*, *Maths Online Interview,* and *Schedule for Early Number Assessment*.

Two challenges particular to the quality of information gained from frameworks and checklists are noted. The first is the extent to which these tools are sufficiently fine-grained. The second is that the extent to which it is possible for teachers to observe behaviours is dependent on a rich environment, the observation skills and recording strategies that a teacher has mastered, the time they have available, and their ability to make an on-balance judgement of observed behaviour and draw an inference back to framework levels. Thus the use of a framework or checklist has only the *potential* to provide information of high diagnostic power.

Additional considerations

Four instruments/tools include attractive features that are worth noting in the development of any new diagnostic tools.

On-line delivery makes *An Even Start* particularly engaging for students. On-line delivery can be attractive for teachers also. The *Assessment for Common Misunderstandings* is available on-line (but is not completed on line) and the site has a range of accessible support materials including, for example, general information on common misunderstandings.

Of additional interest to teachers is likely to be the *Assessment of Student Competencies* electronic spreadsheet proforma for data entry, and the *I Can Do Maths* group and individual delivery instructions.

The Australian Early Development Index (AEDI)
As noted already on page 31, the AEDI provides an additional context for the early years diagnostic tools. A detailed overview of the AEDI can be found in Appendix 3.

Of particular relevance here is the *Language and Cognitive Skills* checklist which addresses one of the four AEDI developmental areas. This checklist assesses students' interest in reading and writing; age-appropriate reading and writing; and numeracy skills (including ability to recite specific pieces of information from memory, to understand similarities and differences, to count, to recognise numbers and shapes and to play board games).

The diagnostic numeracy tools in use across the country provide additional (far more extensive) and complementary information to that provided by the AEDI checklist. Quality Early Years diagnostic tools will allow teachers to 'drill down' and focus attention on specific gaps in knowledge, skills and understandings.

Reflections
The evaluation of the diagnostic power of Early Years instruments/tools raises two concerns: the focus of the cited measurement instruments, and the *explicit* information that these instruments provide to teachers.

First, consideration may need to be given to the development of instruments that address strategies and big ideas as well as skills. Second, consideration may need to be given to the development of instruments that

- make explicit the skill base of each question; and
- explicitly expose misconceptions (as do, for example, incorrect responses on the multiple-choice tasks in the *Progressive Achievement Tests*).

Where a student's results are reported as a score only, or as a pattern of unexpected correct and incorrect responses given the student's ability estimate, the usefulness of the information will depend on a teacher's ability to draw inferences, and the assistance provided in the materials accompanying the instrument.

Group 2 Transition Years

Eighteen diagnostic tools used with students in the Transition Years (Years 5-8) of schooling are included in this group of tools.

Table 15 below provides an alphabetical listing of the tools; the Australian states/territories, or countries, in which they are used; and the Year levels addressed. The upper section of the Table contains those tools used only in the Transition Years; the lower section contains tools that are used across a number of years of schooling but that include a Transition Years component. A prose description of each tool can be found in Appendix 2. References are listed in the Numeracy section of the Bibliography.

Table 15 Transition Years Tools

Tool **Transition Years Only**	**State/territory**	**Year level**
Elementary Math Mastery	All states	Years 5-8
QuickSmart and The Cognitive Aptitude Assessment System (CAAS)	NSW, NT, ACT, Vic and SA	Years 5, 6, 7, 8
Scaffolding Numeracy in the Middle Years	Vic	Years 4-8
Tool **Transition Years Component**		
An Even Start	All states	Years 3, 5, 7 below benchmark
Assessment Tools for Teaching and Learning (asTTle)*	New Zealand	Years 4-12
Assessment for Common Misunderstandings	Vic	Prep to Year 8
Cognitive Diagnostic Assessment Tasks (CDAT)	Qld	Years 1-5
Diagnostic Interview	New Zealand	Years 1-9
Diagnostic Mathematical Tasks		Prep to Year 6
Error Analysis Diagnosis in Mathematics (EADIM)	Tas	Years 3-11
First Steps in Mathematics	WA, Qld, Vic, Tas, NT,	Age 3 years to 13 years
Fractions and Decimals On-line Interview	Vic	Years 5-9
KeyMath-R		K to Year 9
Mathematics Developmental Continuum P-10	Vic	P toYear 10
NAPLAN	All states	Years 3, 5, 7 and 9
On Demand Testing	Vic	Years 3-8
One Minute Tests of Basic Number Facts	All states	Addition and Subtraction – 6 year olds to 11 year olds Multiplication and Division - 7.5 years olds to 11 year olds
Progressive Achievement Tests (PAT-M)	Qld, Tas, SA, WA	Years 2-10 or Years 3 to 11 depending on jurisdiction

Focus of the instruments

Table 16 provides an overview of the Number skills addressed by each instrument (observation framework or checklist). Table 17 provides an overview of the Space, Measurement, and Working Mathematically skills, and Key Concepts addressed by each instrument.

The upper sections of each Table contain those tools used only in the Transition Years; the lower sections tools that are used across a number of years of schooling but that include a Transition Years component.

Table 16 Focus of the Transition Years Numeracy (Number and Algebra) Instruments

Tools	**Numeracy Skills Addressed**					
	Number					Algebra
	Counting	*Place Value*	*Operations*		*Patterns and relationships*	
			Whole	*Fractions*		
Transition Years only						
Elementary Math Mastery	✓	✓	✓	✓	✓	✓
QuickSmart and The Cognitive Aptitude Assessment System (CAAS)			✓			
Scaffolding Numeracy in the Middle Years	✓	✓	✓	✓	✓	✓
Transition Years component						
An Even Start	✓	✓	✓		✓	
Assessment for Common Misunderstandings	✓	✓	✓	✓	✓	
Assessment Tools for Teaching and Learning (asTTle)*	✓	✓	✓	✓	✓	✓
Cognitive Diagnostic Assessment Tasks (CDAT)	✓	✓	✓	✓	✓	
Diagnostic Interview	✓	✓	✓	✓		
Diagnostic Mathematical Tasks	✓	✓	✓	✓	✓	
Error Analysis Diagnosis in Mathematics (EADIM)		✓	✓	✓	✓	
First Steps in Mathematics	✓	✓	✓	✓	✓	✓
Fractions and Decimals On-line Interview	✓	✓		✓	✓	
KeyMath-R	✓	✓	✓	✓	✓	
Mathematics Developmental Continuum P-10	✓	✓	✓	✓	✓	✓
NAPLAN		✓	✓	✓	✓	✓
On Demand Testing	✓	✓	✓	✓	✓	✓
One Minute Tests of Basic Number Facts			✓			
Progressive Achievement Tests (PAT-M)		✓	✓	✓	✓	✓

* Tool not used in Australia

Table 17 Focus of the Transition Years Numeracy (Space, Measurement, Chance and Data, Working Mathematically and Key Concepts) Instruments

Instrument	Numeracy Skills Addressed					
	Space		Measure-ment	Chance & Data	Working Mathematically (examples)	Key Concepts
	Shape	*Locate*				
Transition Years only						
Elementary Math Mastery	✓	✓	✓	✓	2.1, 2.3, 2.4, 2.5, 2.6, 2.7, 2.11, 2.17, 2.19, 2.22	✓✓
QuickSmart and The Cognitive Aptitude Assessment System					*Not applicable*	N/A
Scaffolding Numeracy in the Middle Years					2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.11, 2.13, 2.14, 2.16, 2.21, 2.22	✓✓
Transition Years component						
An Even Start*	✓	✓	✓	✓	2.2, 2.4, 2.5, 2.6, 2.7, 2.17, 2.19, 2.22, 2.24	✓✓
Assessment Tools for Teaching and Learning (asTTle)*	✓	✓	✓	✓	*Items were not available*	✓
Assessment for Common Misunderstandings*					2.2, 2.4, 2.5, 2.6, 2.11, 2.16	✓✓
Cognitive Diagnostic Assessment Tasks*					2.4, 2.5, 2.7	✓✓
Diagnostic Interview					2.3, 2.4, 2.5, 2.7, 2.11, 2.16, 2.17, 2.22	
Diagnostic Mathematical Tasks*	✓	✓	✓	✓	2.2, 2.3, 2.6	✓✓
Error Analysis Diagnosis in Mathematics (EADIM)*					2.4, 2.5, 2.6	✓
First Steps in Mathematics	✓	✓	✓	✓	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.8, 2.9, 2.11, 2.12, 2.22	✓✓
Fractions and Decimals On-line Interview					2.1, 2.2, 2.4, 2.5, 2.6, 2.11, 2.19, 2.22	✓✓
KeyMath-R*	✓	✓	✓	✓	2.2, 2.4, 2.5, 2.11	✓
Math Developmental Continuum	✓	✓	✓	✓	2.1, 2.2, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10,2.11, 2.12, 2.13, 2.14, 2.15, 2.16, 2.17, 2.20, 2.21, 2.22, 2.23, 2.24	✓✓
NAPLAN*	✓	✓	✓	✓	2.2, 2.3, 2.4, 2.5, 2.7, 2.8, 2.17, 2.19	✓
On Demand Testing	*Items on the adaptive test do cover these areas. However, no data specific to each concept is available. Linear Tests cover number only.*					✓
One Minute Tests of Basic Number Facts*					*Not applicable*	NA
Progressive Achievement Tests (PAT-M)*	✓	✓	✓	✓	2.2, 2.3, 2.4, 2.5, 2.7, 2.8, 2.17, 2.19	✓

✓✓= to a large extent ; ✓= to some extent underpinned by age and topic appropriate concepts
* = dependent on the classroom program being rich and educationally sound to provide opportunities for assessment in these areas.
Appendix 5 provides a list of the sub-skills (2.1-2.9) included under working mathematically in the Transition Years.

Evaluation of the Instruments/tools

Two evaluation perspectives are provided as a basis for discussion, reflection and recommendations:

- comparison of the instruments/tools using the framework of seven quality criteria with an emphasis on those criteria that relate to *engagement*, *ease of use for teachers*, *support for intervention*, and *communicating with parents*; and
- evaluations of the diagnostic power of each instrument.

An example of evaluations against the seven quality criteria appears in Appendix 2. The evaluations of the diagnostic power of each instrument/tool were determined by aggregating the evaluations of the three quality criteria that address diagnostic capacity (see Chapter 3, Defining Quality Tools).

Seven quality criteria

Of the eighteen instruments cited, only three address the Transition Years as their sole target group. The others include a Transition Years component. There are some criteria that are addressed by most of the instruments.

All instruments, except the *Error Diagnosis in Mathematics*, were identified as possessing the attributes that are known to engage students to at least a moderate and adequate extent. For some instruments, the extent of engagement is identified in the delivery of the test items. Online delivery (*On Demand Tests*) and one-on-one interviews (the *Fractions and Decimal Online Interview*), for example, are generally seen to be more engaging than a traditional pen and paper test. In addition, the timed aspect of the *One Minute Test of Basic Number Facts* is recognised as an engaging attribute. Items with real-life relevance are also seen to be more engaging than abstract, decontextualised items. Some of the tools consist of a suite of resources and, for these, it is often the learning activities that are engaging for students. For example, the *QuickSmart* intervention program includes motivating, age appropriate games and activities.

All tools also contain clear and sensible instructions to support the general administration of the assessment. In the majority of cases, a separate 'User Guide' is provided with explicit, systematic instructions mapped out. Some include a script (*Elementary Math Mastery*) whilst others provide more general instructions. Some tools also reference Professional Development workshops for teachers to attend (*First Steps in Mathematics*).

Very few of the tools addressed the issues involved with their administration to specific groups to a moderate and adequate extent. Of the Australian tools, only *NAPLAN*, the *One Minute Test of Basic Number Facts*, *PAT Maths* and *QuickSmart* make reference to catering for specific groups. The New Zealand resource, *Assessment Tools for Teaching and Learning (asTTle)*, provides an example of how specific groups are addressed though administration guidelines. The asTTle is designed for use by both English and Maori speakers and thus provides materials in both languages. The items are not translated between languages but are independent of one another. Whilst the English items assess student development against objectives included in the New Zealand curriculum, the Maori items are based on Maori curriculum statements. The 'Test Administration Guide' notes the accommodations that should be made for students identified as having special learning needs and students experiencing personal or social conditions that may affect their performance. It also provides a list of examples of conditions where it may be appropriate to exclude a student from the testing.

All cited instruments, except for the *Diagnostic Mathematical Tasks*, also address the reporting attributes valued by parents to at least an adequate and moderate extent.

Diagnostic power of the instruments

Most of the cited instruments address the criteria related to diagnostic power to at least a moderate and adequate extent. Seven of the eighteen instruments are particularly strong in all criteria relating to diagnostic power: *An Even Start, Assessment for Common Misunderstandings, Fractions and Decimals On-line Interview,* the New Zealand *Diagnostic Interview, QuickSmart* and *Scaffolding Numeracy in the Middle Years.*

Notably, the *Mathematics Developmental Continuum* provides a framework to link the data from a variety of diagnostic tools to curriculum progression points and outcomes. The tool provides 'illustrations' of misconceptions in mathematical understanding and suggests strategies to address these student needs.

First Steps in Mathematics provides a similar framework. 'Diagnostic Maps' describe the characteristic phases in the development of the major concepts in each set of outcomes. 'Levels of Achievement' list the five levels for each mathematic outcome; 'Pointers' list examples of what students might typically do at each level and 'Key Understandings' specify the mathematical ideas that need to be developed in order to achieve each outcome. Teachers use evidence from diagnostic assessments and classroom activities to identify where on the developmental map individual students are located. Learning activities for each level are suggested to target student needs.

The degree to which the instruments focus on knowledge rather than strategies is a challenge for Transition Years tools. The New Zealand *Diagnostic Interview* addresses this challenge by separating the questions into strategy and knowledge questions. In the case of strategy questions, the focus is on *how* a student solved a problem. In the case of knowledge questions, the focus is on *fluent* responses. This 'drilling down' allows teachers to see how a student solved a problem in the process exposing misconceptions that the student may hold. This is feasible with a one-on-one interview, but more difficult in other assessment formats.

As discussed earlier, it is possible to design items to expose misconceptions explicitly, for example, by ensuring that incorrect responses to multiple choice questions reflect common errors and misconceptions (as they do in the *Progressive Achievement Tests).* Teachers can then analyse students' correct and incorrect responses to diagnose students' strengths, weaknesses and misconceptions. *Scaffolding Numeracy in the Middle Years* addresses this issue by requiring students to record all of their working and thinking. This is discussed further below.

Additional considerations

Three tools designed solely for students in the Transition Years were evaluated.

Elementary Math Mastery is a daily program designed to support students to 'fill the gaps' in their knowledge and understandings through direct instruction. Whilst a fundamental part of the program requires teachers to adopt strategies to address individual student needs, *Elementary Math Mastery* does not offer any suggestions of how this may be done.

Conversely, *QuickSmart,* which uses the Cognitive Aptitude Assessment System to monitor student progress, is an intervention program administered to small groups of students with

similar needs. The teaching strategies and materials are clearly mapped to scaffold students in developing fluency and efficiency in basic number facts.

Scaffolding Numeracy in the Middle Years has a focus on higher order multiplicative thinking. The assessment tasks require students to record all their workings and thinking. A rubric is then utilised to match results to one of the eight zones of the Learning and Assessment Framework for Multiplicative Thinking. Further to this, resources are available to address individual student needs.

Reflections and specific recommendations

A challenge for numeracy diagnostic instruments is the use of language. Real-life contexts and contextual items have been identified as being attributes that are engaging for students. However, establishing a context for a question increases its reading load and students with weak reading abilities are limited in showing their true abilities if the item is heavily reliant on language. An advantage of computer-delivered tests is that the context can be established visually with a video or simple animation.

Instruments that do include items with a lot of text must be accompanied by specific administration instructions for students with weak reading ability. As noted above, the majority of the instruments cited do not provide such information or such accommodations. This is in stark contrast to the Early Years instruments where the majority of instruments cited contain extra advice for administration with specific groups.

Elementary Math Mastery, and Diagnostic Mathematical Tasks to a lesser extent, address this challenge by having oral instructions as the delivery mode.

Group 3 Year 9

Nine diagnostic tools are used with students in Year 9 of their schooling.

Table 18 below provides an alphabetical listing of the tools; the Australian states/territories, or the countries in which they are used; and the Year levels addressed. The upper section of the Table contains those tools used only in Year 9; the lower section contains tools that are used across a number of years of schooling but that include a Year 9 component. A prose description of each tool can be found in Appendix 2. References are listed in the Numeracy section of the Bibliography.

Table 18 Year 9 Tools

Tool	State/territory	Year level
Year 9 only		
Grade 9 Assessment of Mathematics	Canada (Ontario)	Year 9
Year 9 component		
Assessment for Common Misunderstandings	Victoria	P – Year 10
Assessment Tools for Teaching and Learning (asTTle)	New Zealand	Years 4 -12
Error Analysis Diagnosis in Mathematics – EADIM	Tasmania	Years 3 -11
Fractions and Decimals On-line Interview	Victoria	Years 5-9
KeyMath-Revised		K – Year 9
Mathematics Developmental Continuum	Victoria	P- Year 10
NAPLAN	All Australian states and territories	Years 3, 5, 7, 9
Progressive Achievement Tests (PAT-M)	Qld, Tas, SA, WA	Years 2-10 or Years 3 to 11 depending on jurisdiction

Table 19 provides an overview of the Number skills addressed by each instrument. Table 20 provides an overview of the Space, Measurement, and Working Mathematically skills, and Key Concepts addressed by each instrument. The upper sections of each Table contain those tools used only in Year 9; the lower sections contain tools that are used across a number of years of schooling but that include a Year 9 component.

Table 19 Focus of Year 9 Numeracy (Number and Algebra) Instruments

Tools	Numeracy skills addressed					
	Number					Algebra
	Counting	*Place Value*	*Operations*		*Patterns and relationships*	
			Whole	*Fractions*		
Year 9						
Grade 9 Assessment of Mathematics			✓	✓	✓	✓
Year 9 component						
Assessment for Common Misunderstandings	✓	✓	✓	✓	✓	✓
Assessment Tools for Teaching and Learning (asTTle)*	✓	✓	✓	✓	✓	✓
Error Analysis Diagnosis in Mathematics – EADIM		✓	✓	✓	✓	
Fractions and Decimals On-line Interview	✓	✓		✓	✓	
KeyMath-R*	✓	✓	✓	✓	✓	
Mathematics Developmental Continuum		✓	✓	✓	✓	✓
NAPLAN		✓	✓	✓	✓	✓
Progressive Achievement Tests (PAT-M)		✓	✓	✓	✓	✓

* Tool not used in Australia

Table 20 Focus of Year 9 Numeracy (Space, Measurement, Chance and Data, Working Mathematically and Key Concepts) Instruments

Tools	Skills addressed					
	Space		Measure-ment	Chance and Data	Working Mathematically (examples)	Key Concepts
	Shape	*Locate*				
Year 9						
Grade 9 Assessment of Mathematics	✓		✓	✓	3.1, 3.5, 3.7, 3.8	✓
Year 9 component						
Assessment for Common Misunderstandings					3.5, 3.7, 3.8	✓✓
Assessment Tools for Teaching and Learning (asTTle)*	✓	✓	✓	✓		✓
Error Analysis Diagnosis in Mathematics – EADIM*					2.4, 2.5, 2.6	✓
Fractions and Decimals On-line Interview					2.1, 2.2, 2.4, 2.5, 2.6, 2.11, 2.19, 2.22	✓✓
KeyMath-R*	✓	✓	✓	✓	2.2, 2.4, 2.5, 2.11	✓
Mathematics Developmental Continuum	✓	✓	✓	✓	3.1, 3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 3.9, 3.10, 3.11, 3.12	✓✓
NAPLAN*	✓	✓	✓	✓	3.5, 3.7, 3.8	✓
Progressive Achievement Tests (PAT-M)*	✓	✓	✓	✓	3.5, 3.7, 3.8	✓

✓✓= to a large extent ; ✓= to some extent underpinned by age and topic appropriate concepts
* = dependent on the classroom program being rich and educationally sound to provide opportunities for assessment in these areas.
Appendix 5 provides a list of the sub-skills (2.1-2.9) included under working mathematically in the Transition Years.

Evaluation of the Instruments/tools

Two evaluation perspectives are provided as a basis for discussion, reflection and recommendations:

- comparison of the instruments/tools using the framework of seven quality criteria with an emphasis on those criteria that relate to *engagement*, *ease of use for teachers*, *support for intervention*, and *communicating with parents*; and
- evaluations of the diagnostic power of each instrument.

An example of evaluations against the seven quality criteria appears in Appendix 4. The evaluations of the diagnostic power of each instrument/tool were determined by aggregating the evaluations of the three quality criteria that address diagnostic capacity (see Chapter 3, Defining Quality Tools).

Seven quality criteria

Instruments that target Year 9 are limited in number, hence only a small sample of instruments for this level were evaluated. Of the nine instruments that are designed to assess Year 9 students, only one Canadian instrument, the *Grade 9 Assessment of Mathematics*, has Year 9 as its sole target group.

The majority of the instruments cited possess many of the attributes that are known to engage students to at least a moderate and adequate extent. Most notable is the *Grade 9 Assessment of Mathematics* which is administered as two pen and paper tests during two different sessions. The booklets contain 24 multiple-choice questions and 7 open-response questions. An attempt has been made to use real-life contexts for a portion of the items, though for some items these contexts seem quite contrived. The other instruments that include the attributes that are known to engage students to a large extent are the *Assessment for Common Misunderstandings*, the New Zealand *Diagnostic Interview* and the *Fractions and Decimals On-line Interview*. The items or tasks involved in the *Assessment for Common Misunderstandings* and the New Zealand *Diagnostic Interview* are 'hands on' and interactive. The online delivery of the *Fractions and Decimals On-line Interview* is also engaging for students. Each of these instruments is administered as a one-on-one interview.

All instruments provide adequate support for teachers to understand what the tool is measuring. For example, one page of the website for *Assessment for Common Misunderstandings* is dedicated to a 'Note on Common Misunderstandings' to provide teachers with a background understanding of the terms 'misunderstandings', 'misconceptions' and 'alternative conceptions'. Within each level, a description of the 'Big Idea' or 'Key Concept' is provided. Details about what students at the end of that level are expected to be able to do are also provided, and a list of common responses to a range of tasks is included together with reasons for these responses. This information not only gives teachers a sound understanding of the theory behind the instrument, but it also provides a means for teachers to interpret incorrect responses which will, in turn, inform their teaching.

Diagnostic power of the instruments

Most of the cited instruments address the criteria related to diagnostic power to at least a moderate and adequate extent. Instruments with high diagnostic power included those that exposed gaps and misconceptions in student learning (*Fractions and Decimals Online Interview*, for example).

The *Grade 9 Assessment of Mathematics*, the only cited instrument that addresses Year 9 in isolation, has a relatively low diagnostic power. The data from this instrument can only provide an overview of student strengths and areas for improvement. Reports are also generated to inform about whole school performances. However, this diagnostic power matches the described intent of the instrument, to 'assess the level at which students are meeting curriculum expectations in Mathematics up to the end of Grade 9.'

Reflections

It is interesting to note that only one of the cited instruments targets Year 9 only. Furthermore, this instrument, the *Grade 9 Assessment of Mathematics*, has very limited diagnostic power. An Australian developed assessment of Year 9 was not identified. Whilst this may seem concerning at first, instruments that include Year 9 as part of their target audience do, as a group, cover the range of diagnostic powers required in Australian schools.

7. FINAL REFLECTIONS

Three sets of final reflections conclude this study. The first set looks with hindsight at some assumptions that underpin the study as it was framed by the initial evaluation criteria. The second looks at the findings of the study from the perspective of a literacy-numeracy comparison. The third looks forward to the possibility of a more coherent suite of tools that will assist classroom teachers to diagnose students' literacy and numeracy strengths and weaknesses; and tailor their teaching to the specific needs of individual students.

1 Some assumptions

In Chapter 3 a distinction was made between the instrument used to collect evidence of learning, and the support provided to teachers to respond to the collected evidence and to communicate information to parents. This distinction was made to highlight the different 'order' of the sets of criteria—the fundamental consideration in the development of diagnostic materials being the capacity of the diagnostic instrument to identify gaps in students' literacy or numeracy skills, knowledge and understandings; the secondary consideration being the support provided to teachers, the third (a single criterion rather than a set of criteria) being the communication of findings to parents.

In relation to communication, two observations are relevant. First, instruments of lower levels of diagnostic power lend themselves more readily to communication with parents than instruments of high diagnostic power because they provide the generalisations that parents seek (for example, overall levels of achievement on a framework, or comparisons with grade expectations). Second, *if* the capacity of diagnostic tools to provide a basis for communicating with key stakeholders is an important criterion for evaluating quality tools, then, in retrospect, there is a communication piece missing: the capacity of a tool (and the expertise of the teacher) to provide a basis for sharing information with students. The older the student is, the more important this communication will be.

2 A literacy-numeracy comparison

Except in the Early Years (and school entry in particular) teachers are using a wider range of diagnostic tools to assess and monitor students' numeracy learning than to assess and monitor students' literacy learning. More numeracy tools than literacy tools are in use; and, as a set, the numeracy tools are able to provide more detailed diagnostic information than the set of literacy tools. This may or may not be of concern. Some possible explanations include that numeracy, because of its relationship with the building blocks of mathematics and the sequential delivery of mathematics curricula, is more easily compartmentalised into skills, underpinning concepts, and processes than literacy; and these sub-areas can be assessed more readily with separate instruments. Another explanation may be that beyond primary school the place of numeracy in subject Mathematics (and the responsibility of teaching numeracy) is clearer than the place of literacy in subject English. A third explanation may be that the skills and concepts underpinning mathematics learning are better understood and/or articulated than the skills underpinning reading comprehension and writing. A fourth possibility is that teachers are more confident about teaching the skills of literacy than numeracy. A fifth is that teachers of literacy/English are resistant to formal assessment.

3 A coherent suite of diagnostic tools and instruments

When teachers make judgements about students' knowledge, skills and understandings, they draw inferences based on observations—the evidence of learning. The more evidence they have, the more accurate the inferences they draw. Some instruments assist teachers to draw inferences of broadly defined dimensions of learning; for example 'number' knowledge (an aspect of numeracy). Others assist teachers to draw inferences about more narrowly defined dimensions; for example, 'counting' (an aspect of number). A numeracy test, for example, that addresses students' number, measurement, space, chance and data understandings (primarily for system monitoring purposes) cannot provide the same fine-grained information about students' understanding of fractions, as an instrument designed specifically for that purpose.

Some tools, particularly in the Early Years, comprise a suite of resources that together provide information at each level of diagnostic power. For example, central to *First Steps* Literacy are maps that identify the phases in a child's development from pre-literacy to independence. The maps are a tool of Level 1 diagnostic power. However, the total suite of resources includes advice to teachers on how to assist individual students to progress. Advice includes recommendations for particular instruments that might assist in this process and these instruments tend to be of level 3 or 4 diagnostic power. The use of the entire suite of linked resources exemplifies the process of 'drilling down' to obtain more detailed information about a student's learning.

The new National Curriculum levels and aligned achievement standards have the potential to provide a similar framework (a diagnostic tool of Level 1 power) across the years of school. Teachers of Year 3, 5, 7 and 9 students will have information from *NAPLAN* (a test of Level 2 diagnostic power) as a starting point for drilling down. Resources such as the NSW *SMART* package will assist them in this process.

Teachers will also need tools of Level 3, and preferably Level 4, diagnostic power to provide detailed and precise information on the strengths and weaknesses of each student. The importance of this very specific information cannot be overestimated. There is growing research evidence to support the tailoring of intervention to the needs of individual students and to 'establishing classroom routines and practices that represent personalized, ongoing, data-driven focused instruction' (Fullen, Hill and Crevola, 2006, p.4; Bransford et al., 2000).

The framework of diagnostic power provides a lens through which it is possible to clarify the relationships between diagnostic tools and instruments and the support needed for teachers to gather, interrogate, understand and use evidence of an increasingly *focused* kind.

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Appendices

Appendix 1 Defining the 'reporting to parents' criterion

The project specification required that one of the criteria for *quality* tools focus on the 'capacity of the tool to provide a basis for reporting to parents'.

To define this criterion the findings of three research studies were synthesised:

Cuttance, P., & Stokes, S. (2000). *Reporting on Student and School Achievement*. Commissioned by the Commonwealth Department of Education, Training and Youth Affairs.

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Key findings of the studies include:

- Parents want reporting to be regular, timely and honest.
- They want reports to be written in plain language (without jargon).
- They want reports to be individually tailored.
- They want a consistent approach taken to reporting across the years of school, particularly the primary/secondary divide.
- They want to know how their child is doing academically and socially, including against expectations.
- They want reports to be interpretive and constructive, showing strengths and weaknesses in a way that will assist them (explicitly) to support their child to move forward in learning.
- Ideally, they want samples of student work to clarify reports and to help them to better understand learning development.

Given that very few tools included in the study were designed with the intention of providing reports to parents directly, the *capacity* of the tools to provide a *basis* for reporting to parents was defined as follows. The tool *itself* provides a basis for

- individually tailored reporting;
- the reporting of academic skills, knowledge and understandings; and
- interpretive and constructive reporting that shows strengths and weaknesses in a students' learning.

Appendix 2 Descriptions of Tools selected into the study

Literacy Tools

AlphaAssess
An Eleanor Curtain Publishing commercial product, *AlphaAssess* is an assessment and teaching tool with benchmark books from Levels 1 to 28. *AlphaAssess* assesses reading and writing, fiction and non-fiction, concepts of print, phonemic awareness, phonics, vocabulary, high frequency words, random letter identification, comprehension and fluency.

Benchmark books, used in conjunction with the blackline masters from *The First Step*, are designed to help teachers assess students' reading levels, strategies and comprehension skills. Practical and explicit teaching strategies that are supported by blackline master activities for both small groups and individuals are provided in *The Next Step*.

An Even Start
An Even Start is a set of assessments developed for use in Australia in the federally-funded National Tuition Program (2008) which is no longer operating. The program provided a minimum of 12 hours of individual or small group tuition in reading, writing or numeracy for students in Years 3, 5 and 7 whose achievement was below the literacy and/or numeracy benchmark standard. *An Even Start* was designed for computer-based delivery (via CD/DVD), but could also be administered in paper-and-pencil format.

Pre-tuition assessments were developed to assist tutors to prepare individual students' tuition plans. The post-tuition assessment, conducted in the final tuition session, measured each child's progress. Reports, which were generated online, included record sheets that identified skills and understandings associated with each item, performance profiles, and analysis sheets.

Assessment of English in the Early Years of Schooling
The Victorian *Assessment of English in the Early Years of Schooling* is designed to provide a comprehensive and reliable profile of a child's strengths and weaknesses in early literacy and numeracy capabilities. It provides point-in-time assessment measures of the progress of government school students towards achieving state-wide standard in English close to the start of the Preparatory year, at the end of the Preparatory year, and at the end of Year 1 and at the end of Year 2.

Assessment of Student Competencies (ASC)
Developed by the Northern Territory DET in 2001 and revised in 2009, the ASC is a diagnostic assessment providing baseline data on students prior to entering compulsory schooling at the age of six years. The competencies identified are the minimum requirement for a child entering compulsory schooling in order for them to make progress in their learning. The ASC aims to inform and guide targeted teaching programs, identify 'at risk' students early in order to place suitable and timely programs to support and assist students and to report on student learning at a class, school and system level. It assesses students' ability to complete mathematics, language and essential learning tasks at Key Growth Point 2 (KGP2), which is the first school entry level of the Northern Territory Curriculum Framework.

The ASC Screening Tool can be used throughout Terms 1, 2 & 3 for Transition students and towards the end of Term 4 for some Preschool students. Opportunities to assess students should be planned and occur as part of the daily classroom program. A purpose-built database

has been developed to streamline the data gathering and biannual reporting processes of the ASC. Teachers are required to record the results of their assessments in this database.

The Screening Tool and all Administration resources are available on the DET website. Websites and activities for teaching and learning activities are suggested in the resources. There are three versions, English as a first language, English as a Second Language and a version for students whose first language is an Indigenous language.

Assessment Resource Banks (ARBs)
The ARBs were first developed by the New Zealand Council for Educational Research (NZCER) in 1998 under contract to the Ministry of Education. They consist of 3116 curriculum-based assessment resources designed for students working at levels 2-5 (Years 3 to 10) in New Zealand schools. They are accessible online. The focus of the resources is assessment for formative purposes and they are designed for teachers to use during their normal classroom activities.

The ARBs include some assessment tasks from national and international monitoring projects (NEMP; PISA; TIMMS). They are aligned to the New Zealand curriculum statements in English, Mathematics, and Science at levels 2 to 5. There is a range of types of tasks, including practical and on-line tasks. Teachers are able to adapt the tasks to suit their students.

Each task is accompanied by extensive teacher notes that support teachers to analyse students' responses. The assessments include formative assessment, summative assessment, diagnostic assessment, self- and peer assessment, pre- and post tests and monitoring school-wide performance over time.

Assessment Tools for Teaching and Learning (asTTle)
A New Zealand Ministry of Education initiative, asTTle is an educational resource for assessing reading, writing and numeracy as well as attitude (in both English and Māori) at Years 4–12. asTTle was first developed by the University of Auckland in 2000.

asTTle can be administered up to four times a year. It is directly linked to the appropriate descriptions of learning and achievement aims and objectives described in the New Zealand curriculum statements. The six curriculum content areas to be found in asTTle are Reading, Pānui, Writing, Tuhituhi, Mathematics and Pāngarau.

The asTTle software package (CD-ROM) allows teachers to custom create the tests out of over 4000 items. asTTle marks the multiple choice questions, the teacher scores the open-ended questions, using the scoring key printed with every test they create. The normed reports provide individual student feedback as well as national comparisons. Teachers can identify subsequent learning steps for individuals, groups, or classes by linking to an indexed online catalogue of classroom resources (What Next). An online version of asTTle (e-asTTle) is available.

Best Start Kindergarten Assessment
The NSW Government initiative, the *Best Start Kindergarten Assessment*, identifies the literacy and numeracy knowledge and skills that each child brings to school as they enter Kindergarten. Assessed are children's early reading and writing, their ability to communicate with others, and how they recognise and work with numbers, groups and patterns.

Best Start uses a continuum that is aligned with the English and Mathematics syllabus for the

early years of schooling. The Kindergarten teacher will observe each child completing tasks, such as talking about a book that has been read, and record what their students know and can do. Teaching and learning activities to support teachers following the implementation of the Best Start Kindergarten Assessment are available on the Department's intranet.

The materials contain Student recording and analysis sheets (literacy), student response sheets (numeracy), analysis guides, class analysis sheets, early literacy continuum, early numeracy continuum and early learning plans for literacy and numeracy.

Burt Word Reading Test – New Zealand Revision
The *Burt Word Reading Test* is an individually administered test that provides a measure of an aspect of a student's word reading skills; that is 'word recognition' for students between the ages of 6 and 13.

The Test Card consists of 110 words printed in decreasing size of type and graded in approximate order of difficulty. A teacher establishes a starting point, then notes pronunciation errors on the individual record form alongside the words read. An examination of these errors may indicate specific weaknesses for further investigation and insight into a student's word attack skills. Administration and scoring take about 10 minutes.

The *Burt Word Reading Test* was standardised in 1980 in New Zealand . No 'reading ages' are provided.

Developmental Assessment Resource for Teachers (DART): English
DART English is an integrated package for the whole class assessment of viewing, reading, listening, speaking and writing, with supplementary assessment tasks to assess students' small group discussion skills and ability to write procedural texts. Two kits are available one for middle primary and one for upper primary students. The DART package provides thematically integrated assessment activities which link good teaching practice with comprehensive assessment practices. Tasks in each dimension are linked onto a common scale.

The reading component of DART assesses students' ability to make meaning from a variety of written text types. Close analysis of the items a student gets right or wrong enables teachers to determine the specific reading skills the student has mastered. There are two tests (Reading Form A and B) which can be used at the beginning and end of a year to measure progress.

DART is referenced against the *National English Profiles* (1994) and the *Curriculum and Standards Framework II* (2000). DART was selected as the tool for gathering quantitative measures of students' literacy achievement in the Successful Interventions Literacy Research Project (DEET, 2001) as well as in the Restart initiative (2002-2004).

EQAO assessments in reading, writing and mathematics (Primary and Junior Divisions)
The EQAO (Education Quality and Accountability Office) developed the assessments in 1999 for the province of Ontario, Canada. The purpose of the annual assessment of reading, writing and mathematics for Grades 1-3 and Grades 4-6 is to assess the level at which students are meeting curriculum expectations in reading, writing and mathematics at the end of the Primary Division (up to the end of Grade 3) / Junior Division (up to the end of Grade 6). The assessments are offered in French and English.

The assessment is paper-and-pencil based and contains open-ended and multiple choice

questions. Rubrics are used for scoring open-ended questions.

The assessments yield individual student, school, school board and provincial results. The achievement levels used to report results for the Primary and Junior assessments are taken from the four-level Ontario Curriculum, which sets Level 3 as the provincial standard. The assessment results provide valuable information to support improvement planning by schools, school boards and the Ontario Ministry of Education. In addition, EQAO publishes a provincial report for education stakeholders and the general public on the English- and French-language versions of each assessment. These reports are available on EQAO's public website.

First Steps Literacy

First Steps, developed by the Education Department of Western Australia and Edith Cowan University, provides teacher professional development and pedagogical strategies to support literacy development in primary schools. A distinctive feature of *First Steps* programs is the maps of development. The maps outline the progression a child makes through phases in each of four aspects of literacy: Spelling; Writing; Reading and Oral Language. Resources provide teachers with a range of strategies to assist individual students to progress along the maps of development.

The First Steps Reading Second Edition has recently been released. The Second Edition builds on the original First Steps resource by drawing upon contemporary research and developments in the field of literacy learning. Links between assessment and teaching are made clear and the resource provides teachers with many practical teaching procedures and activities.

Indigenous Pre-school Profile

A DEST initiative, the *Indigenous Pre-School Profile* was first developed in 2000. The staff in the Performance Evaluation Team of the Indigenous Education Branch (IEB) determined it would be useful for SRA funded preschool providers to have an assessment tool that was generic and useful Australia-wide. Prior to its development, there were no consistent methods available to monitor and report children's competencies in literacy and numeracy.

The Pre-school Profile is a guide that preschool teachers can use to assess the literacy and numeracy awareness and understanding of Indigenous and non-Indigenous preschool children in the child's first language and in English, and ascertain their level of preparedness for school. The Profile overlaps with many of the indicators in the SEA documents each State and Territory uses to determine children's achievement in the early years of compulsory schooling.

Informal Prose Inventory (IPI)

The *Informal Prose Inventory* is a commercial product developed by Handy Resources (NZ). The Inventory is a collection of graded texts that provide a systematic approach to diagnosing and monitoring decoding skills, monitoring retelling and comprehension skills—literal and inferential and tracking reading achievement over time. The 20-minute one-on-one tests measure accuracy, retelling and comprehension and have been carefully selected to fit the Reading Age levels using the Noun Frequency Method. All have been extensively trialled in NZ classrooms.

The Informal Prose Inventory 1, 2 and 3 each comprise nine levels of graded text of increasing difficulty. There are two selections at each level. The three IPI packs contain

administration instructions, graded texts (fiction and non-fiction), running records, Miscue analysis sheets, student scripts and recording sheets. The website provides video tutorials for Comprehension Strategy Instruction to address identified gaps in students' comprehension strategies. IPI ebooks and video tutorials for teachers are available online as well as free sample texts and record sheets.

Kindergarten and Pre-primary Profile

The Western Australian *Kindergarten and Pre-primary Profile* allows for monitoring of children's learning development across six categories (social, emotional, physical, literacy, numeracy, knowledge and understanding of the world and creativity) in relation to Level 1 of the Outcomes and Standards Framework. Judgements are made over time and in different contexts, usually through observation.

The Profile is research-based (developmental theory), used as an ongoing assessment, values prior knowledge, parent contributions, children's cultural identity, linked to the Outcomes and Standards Framework and shows children's progress. It includes child and adult directed interactive learning, play and explicit teaching.

Kindergarten Development Check

The Tasmanian *Kindergarten Development Check* (KDC) is designed to assist teachers in the early identification of Kindergarten students who are at risk of not achieving expected developmental outcomes and may require a specific intervention program and/or support. A set of 21 identified critical core markers determines whether a student is deemed at risk of not achieving expected developmental outcomes.

The Kindergarten Development Check was originally developed for Tasmanian Government Schools in 1994 as a screen to assist in the early identification of Kindergarten students not achieving expected developmental outcomes. It was revised in 1999, republished in 2000 and reviewed in 2002 and 2007, in light of curriculum changes.

The materials in the Kindergarten Development Check have been developed to help teachers to clearly understand the intended meaning of each marker and to build the monitoring process for the Kindergarten Development Check into their Kindergarten program in the most natural way possible. The markers are aligned under the areas of Thinking and Problem Solving, Literacy and Numeracy, and Health and Wellbeing. Activities that will enable children to develop and practise these skills and demonstrate their competence are outlined.

K-7 Literacy Net

The Western Australian K-7 Literacy Net is based on the *First Steps* Developmental Continua which show descriptions of phases of development typically achieved by students across years of schooling. The First Steps materials assist teachers to identify what needs to be learned while the Nets indicate whether students are 'on track' to achieve the designated year level achievement targets through checkpoints for Years 3, 5, 7. These targets are linked to the National Benchmark Standards. P-3 checkpoints are organised into Semester 1 and 2. Years 4-7 have one set of checkpoints for the year. The Net tools are organised under the English (and Mathematics) Outcomes Aspects. Teachers use the class profile to screen the whole class and then identify students for whom individual intervention plans are to be developed.

The diagnostic information is used to identify students who need additional support, to determine the focus of the intervention, and to assist with reporting progress to parents.

National Assessment Program Literacy and Numeracy (NAPLAN)
NAPLAN is a paper-and-pencil based test administered annually to assess the literacy and numeracy skills of all Australian students in Years 3, 5, 7 and 9. Students' Reading, Writing, Language Conventions (Spelling, Grammar and Punctuation) and Numeracy skills are measured and reported on a set of national assessment scales.

Each scale is divided into ten described bands so that the growth in student achievement throughout these years of schooling can be monitored and reported. For each domain and year level, individual student results are reported against six of the ten achievement bands (the six appropriate for their year level), the national average, the middle 60 per cent of Australian students, and the national minimum standards.

The National Education Monitoring Project (NEMP)
The New Zealand NEMP, prepared by the Educational Assessment Research Unit of the University of Otago on behalf of the New Zealand Ministry of Education, assesses students at Year 4 (age 8-9) and Year 8 (age 12-13). It has been used since 1993 in general education settings and 1999 to 2005 in Mäori medium settings.

All learning areas and skills of the NZ school curriculum are assessed annually (on four yearly cycles) to get a broad picture of the achievements of representative samples of New Zealand school students. The English area assesses Listening, Speaking, Reading, Writing and Viewing. The NEMP assessment is reported task by task so that results can be understood in relation to what the students were asked to do.

Each year about 3,000 students in 260 schools are randomly selected to take part in NEMP.
About 100 teachers each year are seconded from schools for a week of training followed by five weeks administering the tasks in the selected schools. Students work on tasks, with the support of a trained teacher-administrator, in four different ways:
1 *One-to-one* One student working with a teacher-administrator.
2 *Group* Four students working cooperatively.
3 *Pencil-and-paper (Independent)* Four students working on their own on the same pencil-and-paper tasks.
4 *Stations* Four students working independently around a series of hands-on activities.

Neale Analysis of Reading Ability
The *Neale Analysis of Reading Ability* is an individually administered untimed test of reading designed for students between the ages of 6 and 12.11 years of age and for special needs students through to adult level. The test assesses oral reading accuracy (discrimination of initial and final sounds; names and sounds of the alphabet, auditory discrimination and blending), silent reading comprehension and writing. The test provides standardised scores, reading ages and national profile levels and is used to make diagnostic observations of reading behaviour and to monitor reading progress.

Observation Survey of Early Literacy Achievement
Marie Clay's *Observation Survey of Early Literacy Achievement* provides a student profile across six skills and assessment tasks:

- text reading (running records)
- concepts about print
- letter identification
- word reading

- writing vocabulary
- hearing and recording sounds in words.

The observation tasks are designed to allow students to work with the complexities of written language; to tell teachers something about how the student searches for information in printed texts; and to tell teachers how that student works with the information. These tasks are indicators of the behaviours which support reading and writing acquisition.

On Demand Testing (English)

The Victorian Curriculum and Assessment Authority (VCAA) *On Demand Testing* is designed to offer teachers information about students' performance (individually or as a group) against the VELS standards in English and Mathematics. The tests are completed, marked and reported on online. Some may also be printed off and done as a pen-and-paper test. The English tests either assess general English or a strand of English (Reading, Spelling or Writing Conventions). There are 'Linear tests', in which all students answer the same questions, and 'Adaptive tests', in which the questions that a student is presented with depend on performance on previous questions. Questions in the English tests are mainly multiple choice, with some short-answer questions in the spelling tests.

The On Demand tests are designed to be used for pre-testing students' knowledge prior to beginning a topic and at the end of a topic, testing new intake students, identifying strengths and weaknesses in individual students, confirming teacher judgements and assisting in the planning of student programs.

Ontario Secondary School Literacy Test (OSSLT)

The EQAO (Education Quality and Accountability Office) developed the assessments in 2000 for the province of Ontario, Canada. The OSSLT assesses whether students have the literacy (reading and writing) skills needed to meet the literacy requirement for the Ontario Secondary School Diploma (OSSD). The Grade 9 Assessment of Mathematics assesses the same for mathematics. The assessments are offered in French and English.

The achievement levels used to report results for the Grade 9 assessments are taken from the four-level Ontario Curriculum, which sets Level 3 as the provincial standard. The paper-and-pen based test features open-ended and multiple choice questions. Rubrics are used for scoring open-ended questions.

The assessments yield individual student, school, school board and provincial results. The assessment results provide valuable information to support improvement planning by schools, school boards and the Ontario Ministry of Education. In addition, EQAO publishes a provincial report for education stakeholders and the general public on the English- and French-language versions of each assessment. These reports are available on EQAO's public website.

Performance Indicators in Primary Schools (PIPS)

PIPS On-Entry Baseline Assessment was developed by the Curriculum Evaluation and Management Centre (CEM) at the University of Durham in England and has been run in Australia by PIPS Australia at the University of Western Australia since 2001. PIPS is not designed to assess students against Australian curriculum objectives.

PIPS assesses the early literacy (reading and phonological awareness) and numeracy skills of students entering primary school. There are two parts to the assessment: the first, or Baseline

assessment is administered early in the year (usually in February) and provides the baseline score. The second, or Final assessment is administered late in the year (usually in October) and shows student progress relative to individual starting points. The Final assessment includes an optional test of the students' short term memory, behaviour and attitude to school.

PIPS is administered on a one-on-one basis. The teacher uses the PC compatible CD-ROM to administer the test. A comprehensive manual accompanies the CD-ROM. An audio track provides the question and the student points to the screen or provides a verbal response which the teacher enters. The administration time is approximately 20 minutes.

The diagnostic reports which contain detailed quantitative data are published within days of administration on AusPIPS, a secure website for submitting data and viewing feedback online. It contains feedback for all years in which a school has participated in PIPS.

Progressive Achievement Test (PAT-R)
An ACER commercial product, PAT-R has been in use since 1973, the Fourth Edition having been published in 2008. PAT-R is a normed test for measuring and tracking student achievement in reading. It can be administered at any time, also twice a year as pre- and post test.

The three main components – PAT-R Comprehension (Yrs 1-10), PAT-R Vocabulary (Yrs 3-10) and PAT-R Spelling (Yrs 2-10) – are each structured so that skills across a wide range of year levels can be assessed validly. The tests have been developed for use in Australian schools. The assessments are linked to the levels of the Australian National Framework (1996).

The tests are administered on paper and can be scored by the teacher or by ACER. The reports show descriptions of the types of literacy skills mastered, student achievement by year level, norm tables, raw scores and scale scores.

QuickSmart and the Cognitive Aptitude Assessment System (CAAS)
The *QuickSmart* intervention and research program attempts to fill some of the identified gaps in research and practice regarding middle-school students with persistent learning difficulties. *QuickSmart* aims to provide an intense intervention focused on basic knowledge and understandings that can equip students with the skills necessary to engage more successfully with classroom instruction.

The *literacy resources* include focus word sheets; pro formas for flashcard sets; reading texts; word meaning and word study sheets; comprehension sheets; guidelines for comprehension and spelling; games; and graph sheets. CAAS is a computer-based component of QuickSmart. Levels of students' higher-order thinking are measured before and after the *QuickSmart* intervention. For the purposes of the *QuickSmart* program, higher-order thinking in reading is conceptualised as word and text comprehension.

School Entry Assessment (SEA)
The SEA is a mandated process used by SA schools to collect, record and analyse the literacy and numeracy development of students in their first year of formal schooling. It provides a baseline for children's learning in the school setting and supports ongoing processes for monitoring and charting children's learning as they move through the early years of schooling to Year 2.

SEA describes literacy and numeracy learning in five developmental stages (Awareness, Exploration, Inquiry, Utilisation and Application). It addresses speaking and listening, reading and viewing, and writing for literacy and, for numeracy, exploring, analysing and modelling data, measurement, number, pattern and algebraic reasoning, and spatial sense and geometric reasoning. It provides a framework with which to observe, record and plan for children's literacy and numeracy development. However, it is not prescriptive in adopting particular classroom based interventions and approaches.

SEA is based on teacher judgement. The information is recorded manually in a Learner Record booklet to provide rich information for parent reporting. Work is under way to enable the electronic recording of individual children's progress at a school level.

Supplementary Test of Achievement in Reading (STAR)
An NZCER commercial product, STAR has been used since 2000 to help teachers to identify those needing extra help, group students by ability and needs, diagnose areas of difficulty, evaluate programmes. STAR assesses word recognition, sentence comprehension, paragraph comprehension, vocabulary range, language of advertising, and reading in different genres. It is used for students in Years 3, 4-6 and 7-9.

The assessment can be implemented at any time of the year and is aligned with the NZ school curriculum. The paper-and-pen based assessment roughly takes 40 minutes to administer and is scored by the teacher, using NZ norms.

Tests of Reading Comprehension (TORCH)
An ACER commercial product, TORCH was first published in 1987. It is used to identify comprehension levels, to measure progress and to use content-referenced interpretation to identify those skills requiring further instruction. The target group are students in Years 3-10. TORCH exists in two difficulty levels (TORCH Plus being more challenging for upper primary and secondary students). TORCH is linked to a 'Reader Behaviour Framework' not to a specific curriculum framework.

A set of twelve reading passages are graded in order of difficulty, varying in length from 200 to 900 words, including fiction and non-fiction texts. Students read a passage and then use a cloze answer sheet to retell the passage, filling in the gaps in their own words to demonstrate understanding.

TORCH can be administered to an individual or a group. TORCH provides teachers with planning, teaching and learning activities to develop students' reading comprehension. Teachers can score the test themselves or have scoring completed by ACER. The reports yield Australian norm- and content-referenced information as well as qualitative descriptions of student achievement.

Year 2 Diagnostic Net
The Queensland Year 2 Diagnostic Net is a process of assessment and intervention to support children's literacy and numeracy development during the early years of schooling. The Net identifies children who are experiencing difficulties in literacy and numeracy. The framework is organised around Reading, Writing and Number, with student skills and behaviours mapped onto developmental continua.

In 1995, the Queensland Government initiated the Year 2 Diagnostic Net to monitor and assess children's development in literacy (reading and writing) and numeracy (number) in

Years 1, 2 and 3. The Government provides additional support for those children who are experiencing difficulties. The Net is used in all Queensland State schools, Catholic schools and some Independent non-state schools.

To monitor a child's progress, teachers use commonly agreed milestones, or *key indicators*, of literacy and numeracy development. These indicators of development provide teachers with a framework for observing the literacy and numeracy achievements of children in the early childhood years. The indicators are grouped in phases on developmental continua which are based on WA's First Steps Project. The Year 2 Diagnostic Net is based on teacher judgement and observation. Specially designed validation assessment tasks are used to confirm judgements about student progress.

As part of the Year 2 Diagnostic Net processes, all parents of Years 1, 2 and 3 children receive standard written reports. For each of the focus areas in literacy and numeracy, the written report tells parents the phase at which their child is operating and provides a brief description of that phase. The report may also contain teacher comments on the child's progress in each area.

Numeracy tools

An Even Start – National Tuition Program
Even Start was used in 2008 under the federally-funded National Tuition Program. It no longer operates. This program provided a minimum of 12 hours of individual or small group tuition in reading, writing or numeracy for students in Years 3, 5 and 7 who fell below the relevant literacy and/or numeracy benchmark. An Even Start was mainly designed for computer-based delivery (via CD/DVD), but could also be administered in paper-and-pencil format.

The tuition included pre- and post-tuition assessments. The pre-tuition assessment helped the tutor design an individual tuition plan for each child. The post-tuition assessment, conducted in the final tuition session, measured each child's progress. Reports were generated online. They contained record sheets that identified skills and understandings associated with each item, performance profiles and analysis sheets.

Assessment for Common Misunderstandings (DEECD, Victoria)
The Assessment for Common Misunderstandings is intended to provide teachers with a set of easy-to-use diagnostic tasks that expose critical aspects of student thinking in relation to key aspects of Number, and to provide advice on targeted teaching responses to common misunderstandings. It can be used from Prep to Year 10, when a teacher suspects students are under achieving, or require more information about student thinking. It is linked to Victorian Essential Learning Standards. A small number of 'stand-alone' tasks are provided at each of six levels. The tasks have been designed to be administered individually, and generally take between 5 and 10 minutes.

Assessment of Student Competencies (ASC)
Developed by the Northern Territory DET, the ASC is a diagnostic assessment providing baseline data on students prior to entering compulsory schooling. The ASC aims to inform and guide targeted teaching programs, identify 'at risk' students early in order to place suitable and timely programs to support and assist students, and to report on student learning at a class, school and system level. It assesses students' ability to complete mathematics, language and essential learning tasks at Key Growth Point 2.

Assessment Tools for Teaching and Learning (asTTle)
A New Zealand Ministry of Education initiative, asTTle is the first bilingual standardised educational assessment instrument published in New Zealand. It is an educational resource for assessing reading, writing and numeracy as well as attitude (in both English and Māori) at Years 4–12. asTTle was first developed by the University of Auckland in 2000.

asTTle can be administered up to four times a year. It is directly linked to the appropriate descriptions of learning and achievement aims and objectives described in the New Zealand curriculum statements. The six curriculum content areas to be found in asTTle are Reading, Pānui, Writing, Tuhituhi, Mathematics and Pāngarau.

The asTTle software package (CD-ROM) allows teachers to custom create the tests out of over 4000 items. asTTle marks the multiple choice questions, the teacher scores the open-ended questions, using the scoring key printed with every test they create. The normed reports provide individual student feedback as well as national comparisons. Teachers can identify subsequent learning steps for individuals, groups, or classes by linking to an indexed online catalogue of classroom resources (What Next).

e-asTTle, an online version of asTTle, is under development and is expected to become fully available to New Zealand schools in late 2009.

Cognitive Diagnostic Assessment Tasks (CDAT)
CDAT aim to elicit students' understanding of the important mathematical concepts and processes that are required for processing whole numbers, fractions and probability effectively. CDAT are designed for use by teachers in formative and summative classroom assessment.

Students in Years 1-5 can be assessed on their number, fractions, chance and data skills multiple times a year with CDAT. The tasks have been categorised as Levels 1 to 5. These levels do not represent Year/Grade levels; rather, they represent concept development levels. CDAT focus on the abstract (decontextualised) mathematics that is based on system, pattern and structure. Because they are decontextualised, the mathematical ideas inherent in one domain (e.g. fractions) can be transferred to other domains such as decimal fractions, measurement, proportion and probability.

Diagnostic Interview (New Zealand)
The Diagnostic Interview, developed by the NZ Ministry of Education, is part of the Numeracy Project Assessment, for use between school entry and Year 8. It is an extensive one-on-one interview resource, linked to the Number Framework within the New Zealand curriculum. There are both strategy and knowledge components.

Diagnostic Mathematical Tasks
The Diagnostic Mathematical Tasks (Deakin University) are intended to help teachers to survey children's mathematical performance, identify some of their learning difficulties and to plan programs which will meet individual, small group and whole class needs (Prep to Year 6). It is emphasised that these are diagnostic tasks, not achievement tests. The tasks were based on the Victorian curriculum, and revised with reference to the National Statement on Mathematics (1990).

Early Years Numeracy Interview
The Early Years Numeracy Interview was developed in Victoria as part of the Early Numeracy Research Project, and is intended to enable teachers to identify the most sophisticated strategies a student chooses to use in various mathematical areas. Students are required to explain their thinking. The interview is associated with a framework of mathematical growth points (derived from VELS), to show progression in development of mathematical understanding.

Elementary Math Mastery
Elementary Math Mastery is a short, daily, diagnostic mathematics program for upper primary and early secondary students, as well as remedial students. It incorporates the Australian Mathematical Curriculum Profile. It features 160 lessons, each composed of 20 strands. The stated aim of EMM is to create a common, solid foundation of mathematical understanding for a whole class.

Error Analysis Diagnosis in Mathematics (EADIM) (Tasmania)
EADIM is a process of identifying and correcting common and uncommon errors that students make with aspects of Mathematics. EADIM provides immediate and practical remediation suggestions that should benefit most students. EADIM uses paper-and-pen

multiple-choice tests. The errors were identified by extensive quantitative and qualitative studies involving real students doing real calculations.

When students have completed an EADIM test, their answers are entered into specially written computer software. The computer software then 'diagnoses' any errors made by students and, for each student, categorises the errors according to the type of error and the frequency with which the student is likely to make the error.

EADIM is currently available on CDROM. It includes test booklets, photocopy master sheets and strategy books. The software prints a diagnostic report for the whole class and for each student in the class.

First Steps in Mathematics
First Steps in Mathematics is an Australian mathematics curriculum resource, used to map progress over time. It is commercially available through Pearson Rigby. It is intended for students up to 13 years of age. It is linked to the West Australian Curriculum Framework, and deals in separate books with the strands Number, Measurement, Space, and Chance and Data. It includes 'diagnostic maps', to help teachers make judgements about students' existing understanding of mathematical concepts and select appropriate activities to support the student's progress.

Fractions and Decimals On-line Interview (DEECD)
The Fractions and Decimals On-line Interview is intended to support teachers to assess an individual student's understanding and strategies of the Overarching Ideas in the areas of fractions, decimals, ratio and percentages. It is a one-on-one interview, aided by a range of materials. Reports are available for Victorian government school teachers at whole class, small group and individual levels. Each student is mapped against the points of growth achieved for each of the Overarching Ideas, in order to show where students' levels of achievement are currently, and to where they need to move.

Grade 9 Assessment of Mathematics (Ontario) EQAO
The EQAO (Education Quality and Accountability Office) developed the Assessment of Mathematics test in 2000 for the province of Ontario, Canada, to test whether students have the mathematical skills needed to meet the mathematical requirement for the Ontario Secondary School Diploma (OSSD).

The achievement levels used to report results for the Grade 9 assessments are taken from the four-level Ontario Curriculum, which sets Level 3 as the provincial standard. The paper-and-pen based test features open-ended and multiple choice questions. Rubrics are used for scoring open-ended questions.

The assessments yield individual student, school, school board and provincial results. The assessment results provide valuable information to support improvement planning by schools, school boards and the Ontario Ministry of Education. In addition, EQAO publishes a provincial report for education stakeholders and the general public on the English- and French-language versions of each assessment. These reports are available on EQAO's public website.

I Can Do Maths

I Can Do Maths is developed by ACER, with a stated purpose of informing teachers and parents about children's development in numeracy in the early years of schooling. The orally-presented tasks have been developed based on the National Profile in Mathematics (1994) learning outcomes (Levels 1, 2 and early 3). Reports include information about Number, Measurement, and Space and total score. Different reports provide normative comparisons with scores of other students at various levels of schooling, details of strengths or weaknesses revealed by a student's pattern of responses, and a student's total score on the score scale.

Indigenous Pre-school Profile

A DEST initiative, the Indigenous Pre-School Profile was first developed in 2000. It is a guide that pre-school teachers can use to measure the literacy and numeracy awareness and understanding of Indigenous and non-Indigenous preschool children in the child's first language and in English, and therefore ascertain their level of preparedness for school in these particular areas. The reports show the progress of each child in each of the criteria in terms of modelled, shared or independent stages.

KeyMath Revised – A Diagnostic Inventory of Essential Mathematics

KeyMath-R is intended to be an individually administered instrument that in 35 to 50 minutes can provide a comprehensive assessment of a student's understanding and application of important mathematics concepts and skills. The KeyMath-R tasks are orally presented individually for the student to respond to verbally, with the exception of 18 equations in each of the operations subtests to be responded to in writing. It was developed after a review of USA mathematics curricula. Reports include, under Basic Concepts, scores for Numeration, Rational numbers, Geometry; Operations include scores for Addition, Subtraction, Multiplication, Division, Mental Computations; Applications include scores in Measurement, Time and Money, Estimation, Interpreting data, and Problem solving.

Kindergarten and Pre-primary Profile

The Kindergarten and Pre-primary Profile allows for monitoring of children's learning development across six categories (social, emotional, physical, literacy, numeracy, knowledge and understanding of the world and creativity). Judgements are made over time and in different contexts, usually through observation. It includes child- and adult-directed interactive learning, play and explicit teaching.

K-7 Numeracy Net (Western Australia)

The K-7 Numeracy Net is used with First Steps Developmental Continua in Western Australia to show descriptions of phases of development typically achieved by students across years of schooling. The First Steps materials assist teachers to identify what needs to be learnt next while the Net determines whether students are 'on track' to achieve the designated year level achievement targets (AT) through checkpoints for Years 3, 5 and 7. These are linked to the National Benchmark Standards. Teachers use the class profile to screen the whole class and then identify students for whom individual intervention plans are to be developed.

Mathematics Developmental Continuum P–10

The Mathematics Developmental Continuum P–10 is a Victorian tool, linked with VELS. It is intended to help teachers identify students' current mathematical thinking (often through focused observations or diagnostic tasks) and plan for purposeful teaching for individuals and small groups of students with similar needs. Students' current mathematical thinking is identified in the form of 'indicators of progress', which are points on the learning continuum. The indicators of progress are not intended to capture all aspects of learning within a

dimension; they often highlight common misconceptions of students. Capabilities assessed are: Number; Space; Measurement; Chance and Data; Structure; and Working Mathematically.

Maths Online Interview (Victoria)
The Victorian Maths Online Interview is used by teachers in a one-on-one interview situation to determine Prep to Year 4 students' existing mathematical knowledge (number, measurement and space) in relation to points of growth. Analysis of the responses provides teachers with powerful information to use when planning to meet student learning needs. The Interview uses mainly hands-on tasks incorporating concrete materials. The focus is on mental computation and on the strategies that the students use. There are 61 questions and sub-questions ranging from Level 1–4 (VELS). The Interview takes 30-40 minutes.

An online data collection aspect will provide teachers, schools, regions and the system with the ability to retrieve and interpret data to inform instruction and to track students' progress over the course of the compulsory years.

NAPLAN (National Assessment Program Literacy and Numeracy)
Since 2008, NAPLAN annually assesses the literacy and numeracy skills of all Australian students in Years 3, 5, 7 and 9. Reading, Writing, Language Conventions (Spelling, Grammar, Punctuation) and Numeracy skills of all Australian students are measured against common national assessment scales. It is a paper-and-pencil based test. There is one main test form and one secure equating form at each year level.

For each domain and year level, individual student results are reported against the six achievement bands for their year level, the national average, the middle 60 per cent of Australian students and the national minimum standards. A 10-band scale has been constructed to span all participating year levels so that the growth in student achievement throughout these years of schooling can be monitored and reported.

On Demand Testing
On Demand Testing is an online resource provided by the Victorian Curriculum and Assessment Authority. It provides online testing materials in the areas of Literacy and Numeracy for the Victorian Essential Learning Standards levels 2 to 6. Teachers can choose from a range of tests (standard linear, progress and computer adaptive) to suit their needs. The standard linear and progress tests may be administered through online delivery or printed for a pen and paper style test. Reports can be generated from the data and guidelines are provided to assist teachers in their interpretations of these results.

One Minute Tests of Basic Number Facts
One Minute Tests of Basic Number Facts (published by ACER) is a test used to screen a whole class for automaticity of number facts; it may also be used with individuals. The focus is on Addition & Subtraction (for 6–11 year-olds) and Multiplication & Division (for 7.5–11 year-olds). The accompanying book aims to provide a range of high quality 'first teachings' of numeracy skills to prevent students failing in the initial acquisition of basic facts. Individual tests can be analysed to reveal misconceptions, strengths and weaknesses in the recall of basic number facts.

Performance Indicators in Primary Schools (PIPS)
PIPS assesses the early literacy (reading and phonological awareness) and numeracy skills of students entering primary school. There are two parts to the assessment: the first, or Baseline assessment is administered early in the year (usually in February) and provides the baseline score. The second, or Final assessment is administered late in the year (usually in October) and shows student progress relative to individual starting points. The Final assessment includes an optional test of students' short term memory, behaviour and attitude to school.

PIPS is administered on a one-on-one basis, using a CD-ROM. An audio track provides the question and the student points to the screen or provides a verbal response which the teacher enters. The administration time is approximately 20 minutes. A comprehensive manual accompanies the CD-ROM.

The diagnostic reports which contain detailed quantitative data are published within days of administration on AusPIPS, a secure website for submitting data and viewing feedback online. It contains feedback for all years in which a school has participated in PIPS.

PIPS On-Entry Baseline Assessment was developed by the Curriculum Evaluation and Management Centre (CEM) at the University of Durham in England and has been run in Australia by PIPS Australia at the University of Western Australia since 2001. PIPS is not designed to assess students against Australian curriculum objectives.

Progressive Achievement Test (PAT-M)
An ACER commercial product, PAT-M has been in use since 1984, the Third Edition having been published in 2005. PAT-M is a normed test for measuring and tracking student achievement in mathematics. It can be administered at any time, also twice a year as pre- and post-test.

The target group is Years 2 to 10 (Vic, NSW, ACT and Tas) and Years 3 to 11 (Qld, NT, SA and WA). PAT-M is designed for use in Australian schools to provide objective, norm-referenced information to teachers about the level of achievement attained by their students in the skills and understanding of mathematics. PATMaths Plus, similar to but a little more difficult than PAT-M Third Edition, are currently being prepared: these will be available on-line late in 2009.

PAT-M consists of one screening test (Test A) and seven tests of increasing difficulty. It is administered in paper-and-pencil format with a choice between OMR or non-OMR answer sheets. Administration happens individually or in pairs. The tests can be scored by the teacher or by ACER. Comprehensive tables show the location of all test questions in comparison to State and Territory curriculum outcomes. The reports show descriptions of the types of mathematics skills mastered, student achievement by year level, norm tables, raw scores and scale scores.

QuickSmart and the Cognitive Aptitude Assessment System (CAAS)
QuickSmart is a theory-based educational intervention for students in Years 5 to 8. It aims to provide an intense intervention focused on basic knowledge and understandings that can equip students with the skills necessary to engage more successfully with classroom instruction. It is the approved numeracy intervention for NSW schools. CAAS is a computer-based component of QuickSmart.

Scaffolding Numeracy in the Middle Years
Scaffolding Numeracy in the Middle Years (RMIT) is intended to enable teachers to identify what their students (in Years 4–8) understand and need, then scaffold them to higher-order multiplicative thinking. The assessment task booklet is designed for students to show all working and explain answers and thinking. Scores are mapped on to the Learning and Assessment Framework

Schedule for Early Number Assessment (SENA)
SENA is the key component of the Count Me In Too (CMIT) professional learning project in numeracy, which focuses on how kindergarten to Year 6 students develop key early number concepts and the strategies they use to solve arithmetic tasks. CMIT was developed by the NSW Department of Education and Training in 1999.

Two diagnostic interview assessment schedules, the Schedule for Early Number Assessment 1 (SENA 1) and the Schedule for Early Number Assessment 2 (SENA 2), provide teachers with information on students' understandings of number formation and strategies used to solve problems.

The Learning Framework in Number (LFN) was developed for the Count Me In Too project in 1996 by Professor Bob Wright. Count Me In Too uses the LFN as a tool to assist teachers to get inside the learning process and appreciate the purpose of structured learning opportunities

The SENA testing is performed on a one-to-one basis. Teachers make informed judgements about students' strategies for solving number problems. The LFN provides guidance in analysing students' responses. The information attained from the SENA testing is then used to map where the student is currently working in the LFN. The framework is made up of five stages starting with more basic skills, and increasing to more complex strategies.

School Entry Assessment (SEA)
The SEA is a mandated process used by SA schools to collect, record and analyse the literacy and numeracy development of learners after 10 weeks at school. It supports ongoing processes for monitoring and charting children's learning as they move through the early years of schooling to Year 2. It covers speaking and listening, reading and viewing, and writing for literacy and, for numeracy, exploring, analysing and modelling data, measurement, number, pattern and algebraic reasoning, and spatial sense and geometric reasoning.

SMART (School Measurement, Assessment and Reporting Toolkit)
The School Measurement, Assessment and Reporting Toolkit (SMART) system is a diagnostic tool that provides feedback to NSW schools and their communities. SMART aids schools in the analysis and interpretation of results from state-wide and national testing programs (e.g. NAPLAN). At any of these levels, areas of strength and under-achievement can be determined. The SMART software links test items to the NSW syllabuses, and provides access to over 800 electronic pages of specifically targeted teaching strategies linked to skills underpinning NAPLAN test items.

Year 2 Diagnostic Net (Queensland)
In 1995, the Queensland Government initiated the Year 2 Diagnostic Net to monitor and assess children's development in literacy (reading and writing) and numeracy (number) in Years 1, 2 and 3. It identifies and provides additional support for those children who are

experiencing difficulties in literacy and numeracy. It is conducted in all Queensland State schools, in Catholic schools and in some Independent non-state schools.

To monitor a child's progress, teachers use commonly agreed milestones, or *key indicators*, of literacy and numeracy development. These indicators of development provide teachers with a framework for observing the literacy and numeracy achievements of children in the early childhood years. The indicators are grouped in phases on developmental continua (based on WA's First Steps Project). The Year 2 Diagnostic Net is based on teacher judgement and observation. Specially designed validation assessment tasks are used to confirm judgements about student progress.

As part of the Year 2 Diagnostic Net processes, parents receive standard written reports. For each of the focus areas in literacy and numeracy, the written report tells parents the phase at which their child is operating and provides a brief description of that phase. The report may also contain teacher comments on the child's progress in each area.

Appendix 3 The Australian Early Development Index (AEDI)

General Intentions
The AEDI is designed to present a population level measure of how children in a community are developing by the time they reach school age.

The AEDI will

- enable communities and governments to provide the necessary types of services, resources and support to give children the best possible start in life;
- provide communities with the opportunity to strengthen collaboration between schools, early childhood services, and local agencies;
- enable teachers to individually assess each child's development and help tailor appropriate learning programs; and
- assist policy makers to plan and evaluate place-based initiatives for children.

A national implementation of the AEDI is intended to increase children's chances of

- a successful transition to school;
- achieving better learning outcomes whilst at school; and
- better education, employment and health after school.

Administration and Skills Assessed
Teachers complete a checklist for each child in their first year of full-time school. The checklist contains about 100 questions over the following five developmental areas:

- physical health and wellbeing;
- social knowledge and competence;
- emotional health and maturity;
- language and cognitive development; and
- communication skills and general knowledge.

Diagnostic identification
However, the diagnostic identification of students with particular needs is explicitly stated not to be the aim of AEDI.

The AEDI does not:

- score individual children as developmentally vulnerable or performing well;
- identify children with specific learning disabilities or areas of developmental delay;
- recommend which children should be placed in special education categories, who should receive extra classroom assistance, or whether children should be held back a grade;
- recommend specific teaching approaches for individual children; or
- reflect the performance of the school or the quality of teaching.

For further information and access to the checklists see
http://www.rch.org.au/australianedi/edi.cfm?doc_id=6211

Appendix 4 Examples of Tool/instrument Evaluations

1 Diagnostic Tools Evaluation Sheet

Name of reviewer: ##
Name of Tool: Year 2 Diagnostic Net (Qld)
Learning area: Literacy/Numeracy: Both (Literacy addressed in this evaluation sheet)
Target ages/grades: 1–3

Criterion with sub-criteria		−−	−	+	++
1	Is fit for purpose				X
	Reviewer's comments The Year 2 Net is designed as a diagnostic tool for Years 1–3 in Qld schools; i.e. a smaller range of years than is the focus of this project. It is mandated in State schools, and recommended in non-State schools. It is used over an extended time in the first instance, with teachers monitoring and recording each student's progress in normal classroom situations, against a detailed set of 'key indicators' in reading and writing, organised into 5 phases. Students who have not demonstrated achievement above a certain phase then complete a centrally set 'validation task' to confirm the teacher's observations. These 2 sources of data are used to determine which students require additional help. Where the 2 sources of data are not in agreement, social moderation (within school or within a cluster of schools) can occur. The phases described in its documentation cover the whole of the primary years, but its diagnostic purpose is explicitly tied to the first 3 years of schooling. The Net is currently being revised to align with the Qld Early Years Curriculum Guidelines (original alignment was with the Qld English syllabus).				
	Is technically sound				x
	Reviewer's comments The construct of literacy on which the Net is based is elaborated in detail, with explicit theoretical backing. The indicators within each phase are grouped as follows: for Reading, 'Making Meaning at Text Level', 'Making Meaning Using Context', 'Making Meaning at Word Level', and 'Attitude'; for Writing, 'Content, Organisation and Contextual Understandings', 'Word Usage', 'Editing', 'Language Conventions' and 'Attitude'. The Reading validation task (coding of errors in oral reading) is based on the work of Goodman (1984) among others.				

Criterion with sub-criteria		−−	−	+	++
2	Matches the described intent of the tool (i.e. is designed to illuminate 'gaps')				x
	Reviewer's comments Within its intended range (Years 1–3), the Net strongly focuses initially (in its in-class stage) on what the student has in fact demonstrated (on several occasions), rather than what they have not demonstrated. The implied gaps between the observed achievements are then illuminated by the validation tasks. Discrepancies can be dealt with through social moderation.				
	Includes information on achievement of the skills that underpin reading and writing (for Literacy) or the skills that define a numerate person (for Numeracy)				x
	Reviewer's comments The teacher's observations on each student over time are entered on a detailed 'Individual Student Profile', where the items on the checklist broadly correspond to (but often go into more detail than) the underlying skills as described in this project. The checklists emphasise attitude (and possibly context) to a greater degree than the project's descriptions do. The early phases of reading and writing, in particular, are finely nuanced.				
3	Includes support for teachers in understanding what the tool is measuring (and therefore what is expected of their students)				x
	Reviewer's comments There are separate books for reading and writing which elaborate the phases and key indicators for teachers (incorporating WA's First Steps). The Reading book is 110 pages and the Writing book 140 pages. These include explanations, examples, teachers' notes, behaviours to be encouraged, teachers' experiences, and extensive teaching strategies.				
	Includes strategies for teachers in addressing individual student needs identified by the tool			x	
	Reviewer's comments The extensive strategies presented in the teachers' resource books are basically addressed to general teaching situations rather than specifically individualised, or 'remedial', situations.				
4	Contains clear and sensible instructions to support general administration				x
	Reviewer's comments Instructions on the initial in-class observations are clear and extensive. Instructions on the validation tasks give extensive advice on contextualising the task and dealing with the individual student; instructions for reading, for example, include the sections 'Prepare environment', 'Before reading', 'During reading', 'After reading', 'Coding changes to text', and 'Analysing the running record'.				

Criterion with sub-criteria		−−	−	+	++
	Instructions are contextualised and personalised rather than narrowly procedural.				
	Contains extra advice on practicalities of administration with specific groups				x
	Reviewer's comments The Net materials include a 19-page document on 'Fair and equitable Practices', which elaborates approaches to be taken with a diverse range of students, under the headings 'Aboriginal children and Torres Strait Islander children', 'Disability', 'Gender', 'Geographical isolation', 'Gifted and talented children', 'Language-other-than-English children', 'Learning difficulties', and 'Low socioeconomic background'.				
5	Possesses many of the attributes that are known to engage students			x	
	Reviewer's comments The initial observational stage of the Net occurs within everyday classroom activities. Issues of engagement with the Net at this stage are those that occur in considering students' everyday engagement with school. (One of the key indicators in the Net is Attitude, so that student engagement is part of what is assessed.) The teacher resources emphasise activities and approaches that plausibly encourage engagement. The validation tasks (oral reading from, and writing in response to, one of a range of set texts) depend partly on the appeal of the selected text and partly on the process of contextualisation that is emphasised in the instructions.				
	Possesses many of the reporting attributes valued by parents			x	
	Reviewer's comments The Net reports (in each of Years 1–3) indicate whether the child is exhibiting all, some or none of the key indicators in the five phases. ('None' is reported as 'Not applicable to your child'.) Each phase is summarised in two or three sentences. The report does not associate these phases with particular year levels as standard or desirable. The basic information conveyed by the reports, then, is the child's performance against broadly stated standards. Teachers may also add written comments. Parents are invited to meet with teachers to discuss the report, at which stage the much more detailed 'Individual Student Profile' will be discussed. The nature of this in-person, potentially finer-grained reporting (e.g. the extent to which it includes comparisons of a student's performance with those of the rest of the class) is not prescribed. An additional, important part of the reporting process is the pair of booklets ('Supporting your child's reading development' and 'Supporting your child's writing development'), which provide practical ideas for parents.				

Criterion with sub-criteria		−−	−	+	++
6	Has the potential to bring forth good evidence about student achievement (this is about validity)			x	
	Reviewer's comments The validity of the assessment evidence is based in the first instance on its direct relationship with (embeddedness within) classroom teaching and learning over an extended time. The construct of literacy represented in the Individual Student Profile in the Net appears sound; the indicators that are looked for are detailed but significant.				
	Has the potential to bring forth sufficient evidence for making inferences about student achievement (this is about reliability)			x	
	Reviewer's comments Possible variations in performance at a particular time are counteracted by the continuous nature of the initial in-class observations. Students are required to demonstrate an indicator several times before having it 'checked off'. Remaining discrepancies in assessment judgements may be identified through the validation tasks (these need be taken only by those students identified as needing extra help in the first stage). Unresolved discrepancies may then be discussed at moderation, bringing other teachers' judgements into play. The triple source of information (within-class observation over time, specific assessment tasks, and collaborative teacher judgements) contributes towards the reliability of the assessment. The moderation of Reading in particular, however, may be disadvantaged by the participating teachers not having observed the child in question. Where moderation occurs only within a single school the cross-site reliability obtained may be questionable; where it occurs across schools, it still occurs only within a cluster.				
7	Produces accurate information on expected outcomes of suggested strategies (which are documented with the tool)		x		
	Reviewer's comments The suggested strategies appear to relate to general teaching rather than to specific post-testing help (although directing that help where most needed is the aim of the Net). The expected outcomes of these strategies are the indicators embedded in the various phases in the first instance. That is, the expected outcome is presumed to be reaching a level ('operating in a phase') that would not lead to being diagnosed as needing the extra help.				
	Suggest strategies (which are documented with the tool) that are aligned with international research evidence			x	
	Reviewer's comments Again with the proviso that the strategies are not specifically post-diagnosis, the Net does provide ample, research-supported suggestions for the teaching of literacy.				

2 Evaluation against seven criteria

Tools **MIDDLE YEARS**	**Criterion 1** Is fit for purpose and technically sound		**Criterion 2** Provides a picture of a student's strengths and weaknesses		**Criterion 3** Guides teachers in adopting particular classroom-based interventions and approaches to meet the learning needs of individuals		**Criterion 4** Is easy to use by teachers and diverse school communities	
	Fit for purpose	Technically sound	Matches described intent of tool (i.e. is designed to illuminate gaps)	Includes information on achieve-ment of the skills that underpin reading and writing	Includes support for teachers to understand what the tool is measuring	Includes strategies for teachers to address individual student needs as identified	Contains clear and sensible instructions to support general administration	Contains extra advice for admin. with specific groups
QuickSmart and the Cognitive Aptitude Assessment System(CAAS)	2 (and 3 for CAAS)	3	4	4	4	4	4	3
NEMP	4	4	1	2	3	1	4	2
Ontario Secondary School Literacy Test (OSSLT)	3	4	2	2	4	3	4	4

Tools **MIDDLE YEARS**	**Criterion 5** Is engaging for students and a basis for reporting to parents		**Criterion 6** Has the capacity to identify gaps in students' literacy		**Criterion 7** Provides a source of effective strategies to address students' needs	
	Possesses many of the attributes that are known to engage students	Possesses many of the reporting attributes valued by parents	Has the potential to bring forth good evidence about student achievement	Has the potential to bring forth sufficient evidence for making inferences about student achievement	Produces accurate information on expected outcomes of suggested strategies	Suggests strategies that are aligned with international research evidence
QuickSmart and The CASS	N/A	4	2 (and 3 for CAAS)	2 (and 3 for CAAS)	4	4
NEMP	4	1	4	4	1	1
Ontario Secondary School Literacy Test (OSSLT)	3	2	4	4	3	3

Appendix 5 Working Mathematically sub-skills

Adapted from
Curriculum Corporation (2008). *Statements of Learning for Mathematics*. Retrieved May 2009
http://www.curriculum.edu.au/verve/_resources/SOL_Maths_Copyright_update2008.pdf

Early Years

1.1 actively investigate everyday situations as they identify and explore mathematics, experiment with different ways of changing numbers and shapes, and try to predict the effects of those changes as they search for patterns and relationships they can describe.

1.2 use simple strategies such as searching for similarity, difference and repetition and use these to make sense of the mathematics they are learning.

1.3 interpret situations where mathematics is involved.

1.4 choose and use concrete materials, drawings, lists, tables and some mathematical symbols to represent these situations and describe them in their own words.

1.5 interpret these different representations of mathematical situations and see the connections between them.

1.6 interpret and work through different mathematical situations, make and test conjectures and predictions, and solve a variety of mathematical problems.

1.7 use suitable approaches and check their reasoning, describe the solutions or findings, and attempt to convince others about their reasonableness.

1.8 identify different types of mathematical situations, and describe the important aspects of those situations in their own words or in other ways such as diagrams.

1.9 talk freely about their observations, ideas and approaches, why particular approaches might be used, explaining which facts, strategies and procedures they expect will assist in the solution.

Middle Years

2.1 actively engage in mathematical inquiry as they explore new mathematics and begin to link this with their existing knowledge.

2.2 look for pattern and repetition and try to generalise about various situations.

2.3 restate problems or investigations in their own words to ensure they understand what is required or break a task into simpler steps.

2.4 select and use strategies and approaches that suit each new situation.

2.5 identify and interpret some of the symbols and conventions used to represent mathematical situations.

2.6 choose and use concrete materials, sketches, diagrams, physical models and a range of mathematical symbols when interpreting and representing these situations, including some simple inequalities.

2.7 see the links between different representations of the same situation and use those which make most sense to them.

2.8 make and test straightforward statements, propositions and conjectures as they explore and attempt to explain patterns and relationships.

2.9 reflect on their approaches and conclusions, and describe and generalise about them using specific instances they have observed.

2.10 identify and describe the mathematical nature of various problems and investigations, and specify the significant aspects of those situations.

2.11 communicate about their ideas, findings and approaches, including how they may have used technology.
2.12 make judgements about whether they were successful, and compare them with the ways other students dealt with the same situations.
2.13 extend their use of mathematical inquiry and employ a range of investigative, modelling and problem solving strategies and processes, including the use of technology.
2.14 develop models, investigate and test propositions, hypotheses and conjectures, and identify key assumptions and conditions that apply to working mathematically in different contexts.
2.15 pose questions and formulate statements amenable to straightforward mathematical analysis.
2.16 choose and use words, mathematical symbols and conventions, diagrams, tables and graphs to develop suitable representations of concepts and relationships and to apply skills and processes in mathematical inquiry.
2.17 interpret and evaluate symbols used to represent variables in simple algebraic expressions and formulas.
2.18 are aware that representations in mathematics have evolved over time and are familiar with common variations in their use.
2.19 apply a range of mathematical skills, processes and strategies to make judgements about whether statements are true or false, for particular cases, or in general.
2.20 systematically check reasoning in context, follow simple deductions, and use technologies as appropriate to assist them to explore the possible truth of statements.
2.21 make generalisations in cases where there appear to be no counterexamples and develop informal arguments to justify generalisations.
2.22 communicate about their own or collaborative work, informally and formally in verbal or written forms.
2.23 present problems, describe the background, ideas and approaches, and report on progress, outcomes or results.
2.24 use technology as appropriate to assist mathematical inquiry and in presentation of their work.

Year 9

3.1 develop the breadth and depth of their mathematical inquiry in familiar and unfamiliar situations, and choose and use a broad range of strategies and processes, including technology.
3.2 identify and describe key features of a context or situation for investigation, plan and carry out inquiries, stating key assumptions and conditions.
3.3 compare different models for a given context, make predictions, solve problems and reflect on solution methods, carry out mathematical investigations, and interpret their work in the original context.
3.4 pose questions and formulate propositions, conjecture and hypotheses amenable to mathematical analysis.
3.5 choose and use appropriate mathematical symbols and notations, diagrams, tables, graphs, variables, relations, and equations, to represent concepts and relationships, to apply skills and processes, and to clarify, modify and refine statements.
3.6 understand that mathematics has been refined over its historical development across cultures and explore different approaches to problems.
3.7 apply a broad range of mathematical and logical skills, processes and strategies as they make deductions, and verify and generalise their reasoning.
3.8 seek counter-examples or explore proofs to verify the truth, or otherwise, of various mathematical propositions, conjectures and hypotheses.

3.9 use technology to explore pattern and structure and hence develop generalisations for further consideration.

3.10 communicate about their own and collaborative work, informally and formally in verbal and written form.

3.11 attend to the nature, purpose and scope of the communication, and describe background, ideas and approaches used as they report on progress, outcomes or results.

3.12 use technology as appropriate to assist mathematical inquiry and in presentation and discussion of their work.